Growth and Yield Program
Steering Committee,

Ministry of Forests

A Growth and Yield Modelling Strategy for British Columbia – Summary Report

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Introduction

External strategic pressures over the past few years have significantly increased the importance of growth and yield (GY) information to the continued development of the forest resource. Accordingly, the reliance placed on GY modelling in forest planning and management has increased. Although great strides have been made in the past few years, the Ministry of Forests and cooperating agencies are not yet in a position to adequately serve the current and emerging needs of GY model users without significant changes being made.

This report constitutes the first step in what will doubtless prove to be a long and sometimes arduous process to satisfy the current and emerging needs of GY model users while at the same time coping with reduced financial resources. The strategic recommendations made in this report will be challenging to implement and, we expect, will generate a certain degree of controversy. Nevertheless their development and implementation will be essential if future forest management needs are to be properly addressed.

Our recommendations are relatively broad-ranging and deal with a wide spectrum of nine issue groupings which confront the GY model user in the field – from Ministry GY organisation through data issues, modelling, extension and training. But they fairly reflect what we found and what GY model users told us they were concerned about.

We caution the reader not to view this report as the final, or even the draft, "implementation plan." There are many key players and organizations involved in GY modelling throughout the province and it will be important to gain the confidence of the majority of them, if not all of them, before embarking on the implementation of any of the strategic recommendations. Consequently, these recommendations may require additional refinement before they can be implemented.

Growth & Yield Modelling

The central importance of GY to forest management was summed up by the Forest Productivity Council in 1991.

> *Growth and yield, coupled with forest inventory, provides the information base upon which forest planning and investment strategy rests. Forest inventories provide data on the land base area and the volume of timber on it. A coordinated growth and yield program provides estimates of the rate of forest growth for those stands that have received silvicultural treatments and those untreated stands of natural origin. These necessary measures provide the means to estimate the future yield and quality of the forest under any resources management regime.*[1]

To manage GY issues, both the Forest Productivity Council and the Ministry of Forests have established GY Programs. The objective of both programs is to provide the growth and yield tools and information needed by forest managers to manage forest lands.

GY models are one of the essential tools used in predicting forest growth. These tools have become operational only in the last decade and most advancements have occurred within the last five years or so.

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[1] Secretariat, Forest Productivity Councils of British Columbia (March 1991), *Growth and Yield Program Plan 1991-1995*, Victoria: Inventory Branch, Ministry of Forests.

In this time, GY models have quickly been delivered to the operational levels and are now used by silviculture planners, timber supply planners and inventory specialists.[2]

Growth models are presently used to support several kinds of decisions including:

- timber supply or allowable harvest decisions – how does growth and yield affect timber supply through time?
- silviculture planning – how will specific treatments affect forest growth?
- program monitoring – which silviculture treatments are effective?
- inventory – what is the current and projected forest inventory?

Changing Social Expectations and New Demands on Forest Management

There are an array of constraints, opportunities and threats which affect the GY program and the course of GY modelling. Some of these factors may be found within the GY program while others are external to it.

At the operational level, new provincial initiatives such as the Timber Supply Review (TSR), Forest Practices Code, strategic level land use planning and the Protected Areas Strategy, new forest management approaches and the trend toward collaborative ventures and joint program delivery[3] have each placed new demands on models and vastly increased interest in, and the importance of, GY activities throughout the province.

Additional factors important to GY include market trends, the need to maintain or increase levels of forest-related employment. As well, the protection of biodiversity, wildlife habitat and other values related to the forest have become a greater concern in forest planning, and tree species sites which have been of little commercial value historically are now growing in importance.

As industry and government manage new constraints on the existing fibre supply, they have paid increased attention to growth and yield. As a result, there has been an increased demand for modelling approaches that can handle these additional factors. At the same time, the MOF (which is responsible for much of the GY modelling effort and expenditures) and many of the other cooperating agencies have entered a period of fiscal restraint. This pushes the MOF and others to work more efficiently, seek new mechanisms to fund GY initiatives and explore partnerships and other arrangements which would encourage industry to take on an increased responsibility for GY.

Organizations Involved in GY Modelling

There are several organizations involved in GY modelling including the Ministry of Forests, industry, academia, the Forest Productivity Council, Forest Renewal BC, emerging Growth and Yield Co-operatives and forestry consultants. The activities of each of these groups have or will have some impact on the other. For example, the Ministry of Forest's GY program is guided by the Forest Productivity Council's GY Strategy and FRBC has adopted the strategic priorities of the Forest Productivity Council and the Ministry of Forests programs.

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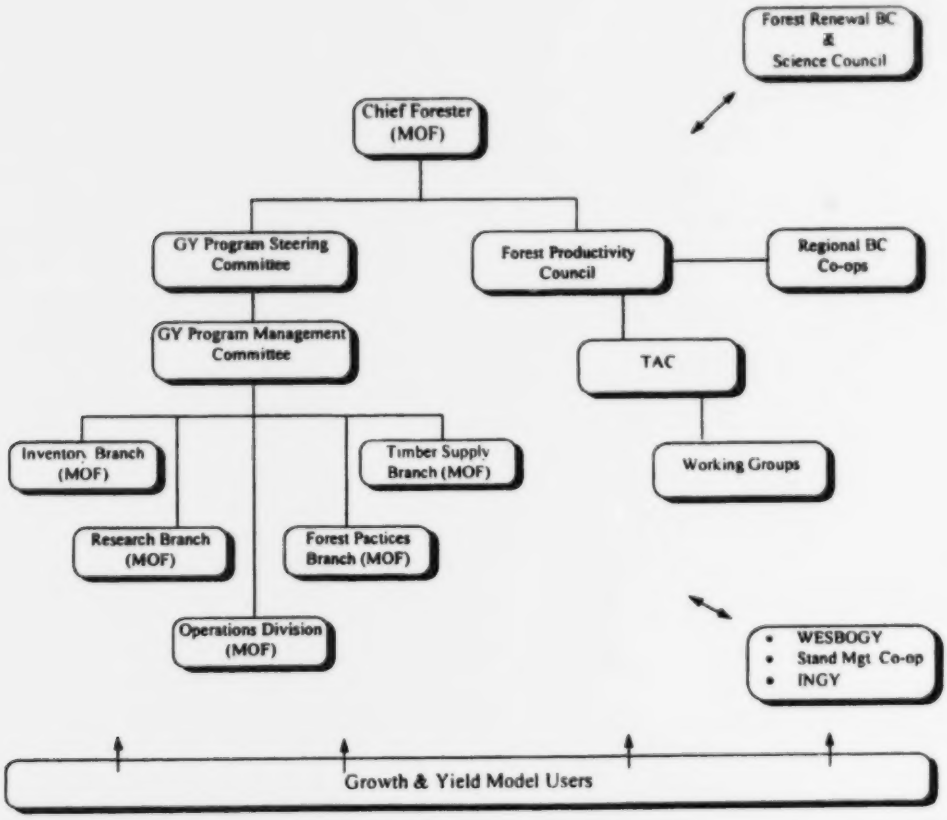
2 Initially, models were developed for research purposes. In BC, the most significant research model is TASS (Tree and Stand Simulator) which was developed by the Forest Productivity Decision Support Section of the Research Branch (MOF).

3 Strategic level land use planning includes Land and Resource Management Planning (LRMP) and the CORE initiated regional planning initiatives that continue to unfold.

Principle Groups Involved in GY Modelling



The Ministry of Forests Growth and Yield Program is a coordinated, inter-branch program consistent with the Forest Productivity Council's current Growth and Yield Program. The MOF's program guides GY activities in the Resources Inventory Branch. Research Branch and the Forest Practices Branch. The Timber Supply Branch is also an important participant but primarily as a user of systems developed and implemented in the other branches. These four branches are part of the Forestry Division for which the Chief Forester is responsible and their GY activities are coordinated through a GY Program Steering Committee (GYPSC). The Forestry Division, in turn, is one of the four divisions into which the Ministry of Forests is divided. The Operations Division is the operating arm of the ministry and is responsible for implementing ministry policy. They use systems and tools developed through the GY program and play a leading role in data collection. In sum, activities pursued through the GY Program are expected to contribute to the achievement of branch, division and ministry wide objectives.

GY Modelling Applications

Growth and Yield models are typically used for three key applications, namely:

- Silviculture planning
- Inventory; and
- Timber supply planning (e.g. the determination of AACs)

Silviculture Planning: Foresters demand models to predict stand growth. These predictions are required to conduct economic assessments of treatment alternatives, help in selecting appropriate silviculture treatment programs, select the individual sites for treatment, and on individual sites, prescribe the right treatment.[4] In the Ministry of Forests, attention has been focused on TIPSY and Prognosis predominantly in the Forest Practices Branch and TASS in the Research Branch.

Inventory: The Resources Inventory Branch has typically used GY models to update and project the inventory of standing timber volumes. VDYP is the primary tool used in this regard.

Timber Supply Planning: GY models provide outputs which in turn constitute one of the inputs for strategic level planning at the TSA and TFL levels. The Growth and Yield models typically used in this regard have been VDYP and TASS/TIPSY.

Outputs of GY modelling have also been used in economic modelling, forest health and the modelling of non-timber resources or biological modelling.

Most modelling effort occurs in the Ministry of Forests at the branch level (Research Branch, Forest Practices Branch, Resources Inventory Branch, and Timber Supply Branch) and operations throughout the Forest Regions and Forest Districts. Modelling is undertaken by major licensees including MacMillan Bloedel, Western Forest Products, for example, and in the forestry consulting community and by the various universities involved in forestry (predominantly UNBC and UBC). The models of greatest use in BC are briefly introduced below.

TASS (Tree and Stand Simulator)

The first substantial outputs of the TASS model were managed stand yield tables for coastal Douglas-fir in *1985*. Throughout the 1980's and early 1990's work continued on TASS, calibrating it for more species. The system continues to be maintained by the Research Branch and has been used intensively in the Timber Supply Analysis conducted for both Timber Supply Areas and Tree Farm Licences. These analyses in turn have been a key input into the decision making process for determining AACs.

TIPSY (Table Interpolation Program for Stand Yields)

Following the publication of yield tables for Douglas-fir (Mitchell and Cameron, 1985). Ministry planners requested the development of software that would give them electronic access to yield table information.[5] TASS generates the metric yield tables contained in WinTIPSY's database. WinTIPSY retrieves appropriate yield tables from its database, customizes the information, and displays the yield summaries. Yield tables are available for various even-aged coniferous species of commercial importance growing on the coast and in the interior of BC. TIPSY is used extensively in timber supply and silviculture planning.

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4 Patrick Martin (January 1997), *Support Centre for Stand Growth models, (FRBC Operations Framework Proposal).*

5 This section from: J.K. Mitchell, SE. Grout, and R.N. MacDonald (Dec. 1995), *User's Guide for Producing Managed Stand Yield Tables with WinTIPSY Version 1.3 under Microsoft Windows*, Victoria, Research Branch, Forest Productivity and Decision Support Section (FPDS), Ministry of Forests, p. 1.

VDYP (Variable Density Yield Prediction)

VDYP was calibrated for coastal and interior species in 1990/91, tested in 1991 and then validated. VDYP has been used extensively in the Timber Supply Review process initiated in 1992 and the most recent version was released in 1994 (version 6.2b). The recent completion of the Vegetation Inventory will likely lead to a major overhaul of the model in the coming years. VDYP was developed for use as an inventory model but has been pressed into service to project future volumes as well

Prognosis

In the late 1980's the Chief Forester endorsed a proposal to support the implementation of the Prognosis model for BC. Prognosis was developed in Northern Idaho to model complex stands. The feasibility of using the model in BC was explored in the early 1990's and, by 1995, the Forest Practices Branch was actively lobbying for Prognosis. They viewed it as the most viable tool available to project complex stands and their future stand structure. Prognosis was released for limited use in BC in 1996, and it is expected that Prognosis will be calibrated with BC data for the Southern Interior Region by the fall of 1997.

STIM & WinSTIM (Stand and Tree Integrated Model)

STIM was developed through the Canadian Forest Service. Although not designed as a silviculture tool, STIM can be used to make projections of treated stands.[6] STIM was developed for both natural and thinned stands of western hemlock. There were plans to calibrate the model for other commercial species such as aspen and white spruce. However, following the termination of CFS' modelling program, development of STIM has all but ceased.

MGM (Mixed Wood Growth Model)

More recently, the Ministry of Forests has been supporting the development of MGM through the WESBOGY Co-operative. The model is expected to meet emerging demands for mixed wood growth models in BC. The primary focus of the model is on white spruce and aspen. When operational, the application of MGM will initially be limited to the northeastern portion of BC.

SPS (Stand Projection System)[7]

The Stand Projection System was developed in the US specifically for coastal Douglas-fir and later calibrated for other species. Several pilot projects were initiated by the MOF to operationalize SPS for use in BC. Over the last few years SPS has fallen into disuse in the MOF. However, it continues to be used in the consulting community and industry where it has strong support.

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[6] G.M. Bonnor, R.J. DeJong, P. Boudewyn and I. W. Flewelling (1995). *A Guide to the STIM Growth Model*, Victoria: Pacific Forestry Centre, Canadian Forest Service.

[7] Secretariat, Forest Productivity Councils of British Columbia (July 1991) *A Guide to Growth and Yield Models of the Pacific Northwest*. Victoria: Inventory Branch, Ministry of Forests.

Strategic Directions for GY Modelling

Vision and Principles

The FPC is presently revising its vision of GY to better accommodate an ecosystem-based approach to GY. The following vision is suggested in this regard:

> *"To be able to consistently and accurately predict the dynamics of BC's forested ecosystems under any resource management scheme."*

Strategic Goals

There are nine strategic areas around which strategic goals and recommendations have been made. The strategic areas and goals are identified below. Issues and recommendations for each of these nine areas are then discussed and presented.

Strategic Area	Strategic Goals
1. Organization, Administration and Liaison	Ensure that the Organisational framework for GY allows for the development of "corporate" approaches to GY and engenders long-term support for GY modelling activities in BC.
2. Resources to Support the GY Program	Secure sufficient resources (including funding, skills and personnel) to pursue GY initiatives of strategic importance in a timely manner.
3. Model Applications	Ensure that application related needs are identified and priorized.
4. Model Inputs and Data Requirements	Ensure that model inputs and data requirements are being collected to use GY models.
5. Model Development, Procurement and Operationalization	Provide specific GY models that meet the needs of clients.
6. User/Model Interface	Develop and maintain a user/model interface that is menu-driven, user friendly and easy to understand.
7. Training	Improve the skills of GY clients to ensure that appropriate and optimal use is made of existing GY models.
8. Extension & User Support	Improve GY clients' level of awareness of GY program and initiatives and provide user support at levels which ensure that optimal use is made of existing GY models.
9. Modelling Standards and Guidelines for Development, Application, maintenance, and Monitoring	Ensure that accepted standards and guidelines for the development, application, maintenance and monitoring of GY models are developed and communicated to GY clients.

The strategic directions, issues and recommendations are discussed below.

Issues and Recommendations

Organisation, Administration and Liaison

Strategic Goal: ***Ensure that the Organisational framework for GY allows for the development of "corporate" approaches to GY and engenders long-term support for GY modelling activities in BC.***

The MOF and other organizations pursuing GY activities remain committed to steering and managing the GY program through interagency mechanisms. To this end, the FPC has recently been reconstituted, a regional co-op appears to be taking root in the Southern Interior and the GY Steering Committee continues to improve the cohesion and coordination within the MOF's GY Program.

There are both positive and negative features of such an approach. Creative solutions often emerge, GY outputs hold greater legitimacy in the GY community, tensions are more easily resolved and client needs may be more easily communicated. But there are also risks. Initiatives may falter or progress according to the issues driving each of the constituent agencies and the GY organisation is more prone to losing cohesion and breaking down.

The organization of GY remains complex. We identified fourteen separate organisations which have responsibility for some part of the program. As a result, the accountability relationships are not always clear. That GY has made significant progress over the last several years is due more to the dedication of the individuals involved rather than any inherent qualities of the organisation.

Our recommendations center on the need for controls which ensure that the GY functions are clearly identified and purposively steered to improve understanding of the framework for pursuing GY and build commitment to and support for the organisational framework. These controls will assist in maintaining a stable, purposeful and accountable organisational and administrative framework which is an essential foundation for the GY modelling strategy.

Recommendations:

1. Formalize the GY program and design and document it according to accepted program design principles. The program design model should include the following features:
   - Identify the players
   - Specify which stakeholders benefit, and how
   - Evaluate alternative means of program delivery
   - Consider compatibility and linkages with other programs, and any potential for overlap or redundancy
   - Maximize cost-effectiveness and efficiency of delivery method chosen
   - Ensure the program is consistent with accepted government management principles
   - Ensure financial predictability and feasibility
   - Allow for program flexibility if conditions change
   - Examine for potentially unintended consequences
   - Determine implementation feasibility and practicality
   - Build in cessation provisions for specific activities, and
   - Design and implement performance measurement and program evaluation systems which may include:
     - identification of success indicators
     - formative evaluations

- needs assessments
- maintaining ongoing monitoring capabilities

The description presented in Chapters 2 and 3 may be used as the starting point for this activity.

2. Develop a new GY communication strategy (including a GY modelling communication strategy) to convey program and strategy details and current initiatives. This strategy serves a two-fold purpose by raising awareness and managing expectations related to GY modelling.
3. Continue to use working groups, co-ops and TACs which have the support of the provincial GY community to undertake well defined, problem oriented projects or tasks. As such these bodies must be:
   - assigned specific terms of reference which:
     - define the problems,
     - explicitly link projects to problems;
     - identify project terms;
     - are limited as to duration; and
     - identify project deliverables.
   - comprised of members from each of the agencies with an interest in a particular initiative; and
   - guided by formal project plans. (The Prognosis BC approach serves as a model for future working group activities.[8])
4. Operate the GY Program under a 10 to 15 year planning horizon to ensure that plans to meet short and long term goals can be properly developed and implemented and that an appropriate balance is maintained between them.
5. Develop a formal business plan for each one to three year "rolling "planning period.

Resources to Support the GY Program

Strategic Goal: ***Secure sufficient resources (including funding, skills and personnel) to pursue GY initiatives of strategic importance in a timely manner.***

There are only a small number of GY experts in the province. Many of these people work within the MOF, while the remainder can be found in industry, private consulting practices and academic institutions. GY experts are a precious resource currently stretched thinly over many initiatives. As a result, some organizations are seeing. increased staff burnout, slow progress on some initiatives, the occurrence of too many projects sometimes managed off of a single desk, and initiatives faltering when a project "champion" leaves or retires. The small pool of available qualified GY experts cannot be brought to bear adequately on all GY issues.

In addition, the capacity to achieve long-term GY objectives is being compromised by the absence of a long-term funding commitment. As such, many of the long-term objectives of research and development work in GY and GY modelling are at risk. Further, given the risk posed to long-term objectives, there has been a tendency to focus efforts on short-term objectives and to develop "quick fixes."

Now that FRBC has become the greatest source of funding for GY initiatives, users feel that the capacity to develop a long-term GY modelling program has been further eroded. During the course of our work, conflicts in funding criteria between FRBC and agencies such as the MOF were identified. In some instances this has caused GY projects of relatively little strategic importance to proceed at the expense of GY modelling initiatives of relatively great importance to the MOF.

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[8] Ministry of Forests (nd.). *Prognosis BC*.

Given these conditions, two key challenges face the GY community. Firstly, issues of strategic importance must be addressed first. As well, sufficient control over the allocation of funding and security of funding over an adequate planning horizon (say 10 to 15 years) is required to ensure that greater emphasis is placed on identifying and working towards long-term objectives.

Secondly, the pool of available GY expertise should be enhanced. Additional training and teaching could be provided (issues addressed in the "training" section below). In addition, the GY program must be more actively promoted as a "career opportunity." The pool of labour may also be boosted somewhat by extending networks to GY experts abroad.

Other aspects which have affected GY resources include the perceived "black box" nature of GY and consequent perceptions that GY-related decisions are overly subjective and biased towards MOF interests. As a result, some organizations have reduced their effort in GY and in other cases, GY experts have left the pool of GY expertise altogether. Recent developments and our recommendations with respect to organisational, administration and liaison-related issues are intended to make some progress in alleviating this problem. Recommendations with respect to standards and guidelines have also been made which address this problem.

Recommendations:

1. FRBC should commit long-term funding to support the GY program in BC. One suggested funding arrangement is to establish an annuity with a term of ten to fifteen years (which is reviewed every 3 to 5 years). The annuity should ensure that current annual expenditure levels are maintained and, if possible, enhanced However, long-term continuity of funding may be as important as its actual level, since many GY projects are long-term in nature.
2. Partnerships between industry, MOF and academia should be promoted as a means to effectively implement and advance the province's GY program and GY modelling, in this regard, greater consideration should be given to incentives that promote industry participation in GY (Without sufficient incentives, continuing commitment to the newly constituted FPC, and GY generally, cannot be ensured.)
3. Co-ops should be promoted as one of the key mechanisms to pool resources between industry, MOF and academia. (Co-ops may be funded through FRBC and industry contributions.)
4. Long-term funding should be used to attract people with required skill sets, alleviating some pressure to develop skill sets locally through academic institutions, industry and the Ministry.
5. Seek out staff with broader skill sets rather than narrow model-specific GY expertise. Acquisition of a generalized skill set enhances adaptability of staff and promotes a more efficient use of human resources.

Model Applications

Strategic Goal: ***Ensure that application related needs are identified and priorized.***

Clients identified stand types, silvicultural systems and treatments and other conditions which cannot be modelled adequately with the GY tools currently available. These included:

- Forest health impacts on GY (root rot in the Southern Interior was identified most frequently)
- Even-aged single species stands for some individual species
- Uneven-aged stands (a need identified in all regions)
- Mixed species stands (in all regions)
- Mixed-wood stands and deciduous stands (identified in the Northern Interior predominantly)
- Succession
- Deciduous stands

- Non-productive stands
- Young stands
- Silviculture treatments including pruning, thinning, spacing and fertilization
- Partial cutting
- Decay and waste
- Wood value and quality modelling
- Stand modelling which is linked to estate level models

As apparent from this list, there are perceived gaps in many areas and a vast GY program would be required to address them. However, given the current climate it is important that gaps of greatest strategic importance to each of the major client groups are addressed first. Care must be taken to avoid the risk of undertaking a modelling effort which is too broad in scope given anticipated resourcing constraints. There is some evidence that at present the GY modelling effort is too diffuse.

Our recommendations are centred on the lack of systematic and "objective" criteria to identify strategic gaps. Such criteria are essential to focus GY modelling efforts to produce meaningful results, in a timely fashion in areas of greatest need.

Recommendations:

1. Document required outputs for tree and stand simulators for each of the client groups.
2. Develop and implement formal criteria for priorizing modelling needs for each of the major client groups.

Model Inputs and Data Requirements

Strategic Goal: ***Ensure that model inputs and data requirements are being collected to use GY models.***

Modelling gaps are often indicative of data gaps. As such, model inputs and data issues are closely related to the theme of model applications.

Apart from this, there is increased focus on the landscape unit for inventory purposes and this has underscored the need for inventory data of a finer resolution than currently available. Similarly, silvicultural planners are becoming concerned that stand level planning is not adequately linked to forest level objectives. In addition, the uncoordinated data collection and storage of GY data has been identified regularly as an impediment to an integrated, coordinated and responsive GY modelling program.

Recommendations:

1. Model requirements should be identified and documented prior to establishing data requirements.
2. An "end-state "for the database supporting GY modelling must be articulated in order to identify data gaps. These gaps are likely to vary in the short term as compared to the long term.
3. Formal criteria for priorizing data needs should be developed for each of the major client groups.
4. Promote the development of an integrated. coordinated. corporate approach to data collection and storage which maximises the use of existing data first.
5. Encourage the GY Co-ops as essential players in the continued development of the province's corporate data system.

Model Development, Procurement and Operationalization

Strategic Goal: ***To provide specific GY models that meet the needs of clients.***

There is currently no formal means of planning the acquisition of a model and approving its fitness for purpose. Nor is there a certification process which enables a user to know that the model he/she is using fits the data; does what he/she expects it to; has been subjected to a rigorous peer review process; and works according to a set of pre-determined standards. These are essential features which users have every right to expect.

Several initiatives are underway which will make some progress in satisfying the unmet client needs which were described to us. Work continues on Prognosis, TASS and MGM, for example. However, many clients believe that efforts to procure, develop and operationalize models have been inadequate and interview evidence suggests that efforts have not always been sufficiently well co-ordinated. Many have felt that the development of Prognosis BC has progressed too slowly while other models such as SPS have lost MOF support altogether (although still available for use in some districts) or shelved (WinSTIM). Efforts to identify other GY models which may meet particular user needs have been viewed as inadequate by some clients.

Recommendations:

1. Formalize the development/procurement process by including the following explicit functions:
   - Identify the business gaps (what we need versus what we have);
   - Articulate the business need;
   - Scan for existing models (BC and elsewhere) which will meet the business need:
   - Build only if there is no appropriate model to buy;
   - Address data issues refit and validation.
   - Address data issues re model operation; and
   - Develop and articulate strategies for
     - procurement versus building models,
     - data, and
     - operationalization.
2. Conduct an ongoing scan of models used and identify models which could be used in BC. Review should be undertaken by the FPC through an appointed TAC.
3. Models selected for use in BC should be approved and certified for use by the FPC.
4. Licensing/liability issues for GY models must be identified clarified and addressed as part of the model development, procurement and operationalizing process.
5. Criteria for investment in GY models should be established and should include costs, business plan, technical requirements, risk management issues and data availability.
6. Prognosis, MGM SPS, TASS, TIPSY Y-Xeno etc. must be accommodated in an FPC approved strategy.

User/Model Interface

Strategic Goal: ***Develop and maintain a user/model interface that is menu-driven, user friendly and easy to understand.***

GY clients identified the need for a user-friendly interface. Clients noted that some models were very difficult to use and that a Windows environment or simplified front-end would improve accessibility. Others noted that, at times, they found themselves jumping from one model to the other and that a common interface for all models currently in use would be helpful. Finally, some found that the inaccessibility of TASS is adversely affecting their approach to modelling. Although, the support staff for TASS has been quick to respond to client requests for special runs, clients note that this relationship is cumbersome.

Recommendations:

1. A common architecture should be developed for GY models used currently. This architecture would be corporate in nature, housing inventory, silviculture and timber supply models.
2. Prior to developing this architecture there is a need to conceptualize a modelling system with a decision key that allows identification of model(s) appropriate to specific needs.
3. Simplify interface for specific models. When feasible, a Windows format should be developed with sufficient depth to allow users to understand implications of approaches.

Training

Strategic Goal: ***Improve the skills of GY clients to ensure that appropriate and optimal use is made of existing GY models.***

The need for more training in GY modelling was identified frequently by model users. A lack of training has contributed to misapplications in modelling, and an unnecessary limit on the diversity of GY tools employed.

Some also identified the need to provide training in models such as WinSTIM and SPS. In the case of the latter we were told by one interviewee that SPS, although once used in the District, had fallen into disuse because the person conversant with the model had left, despite considerable effort and expense made to calibrate it for the district. An obvious result is that models which may be available for use are not being used as widely as they could be.

GY training provided through degree granting institutions was also identified as inadequate;

Recommendations:

1. A concerted effort should be made in the shorter term to increase the level of user training for GY users in the field.
2. A training needs study should be implemented to identify the specific training requirements.
3. A "stand alone" GY training module for foresters should be developed to meet the needs, based on the current SIBC Module 3 curriculum, and offered independently of other SIBC courses.
4. The module should be delivered through SIBC. using private sector trainers where possible and/or the facilities of the Forests Continuing Studies Network

5. MOF should reduce its direct involvement in the delivery of GY training courses.[9]
6. In the longer term, the FPC should promote additional GY knowledge transfer through degree granting institutions. This might include:
   - Establishment of GY training as a mandatory component in a B.Sc. degree in forestry;
   - The attraction of graduates in quantitatively oriented degree courses such as computer science and engineering to work in the forest GY field; and
   - Providing strong support for financial resources needed to implement GY training where there is a need.

Extension & User Support

Strategic Goal: ***Improve GY clients' level of awareness of GY program and initiatives and provide user support at levels which ensure that optimal use is made of existing GY models.***

Model users identified that the quality of extension efforts and user support has improved significantly in the last few years. However, several outstanding concerns were identified. Model users need information about all of the tools available currently whether they are (or are expected) to be in use predominantly in industry or the MOF. For example, although SPS and Y-XENO tend to be used predominantly in industry and the consulting community, there is still a need to provide MOF personnel with background information on each of these models. In some cases this information is required because MOF personnel may be faced with the task of approving plans or outputs which were developed using these models.

Modellers also noted that they were not always sure when to use a particular model. They noted that more effort was needed to communicate model parameters to GY clients and to provide a decision key that allows them to identify models that are appropriate to their needs.

Users identified the need for demonstrations of real life scenarios interpreted for specific models. This was identified as an important extension activity that could aid in promoting a common core approach to modelling and interpreting real conditions in terms of particular models.

Finally, clients reported some confusion with respect to which models have been approved for use (especially with respect to silviculture). In part this perception is due to the lack of user support for some models (e.g., WinSTIM) and the consequent perception that these models were not endorsed by the MOF.

To date, extension and user support efforts have been focused on WinTIPSY and VDYP. Interview evidence suggests that these efforts have been well received by GY clients, but, a greater commitment to extension is needed.

Recommendations:

1. A user support function should be established to provide assistance to GY users in the field. The service should include quick advice on the GY models approved for use, including the advantages and disadvantages of the use of specific models in the circumstances identified by the user.
2. GY users in the field should be kept up to date on GY developments taking place in the MOE head office, or in other areas, which affect them directly or indirectly. The best way to do this would be through the MOE internet service.

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[9] During the course of the study, it was argued that in the ministry, GY experts' time was better spent in research and model development rather than in the delivery of training. This recommendation is therefore intended to ensure that GY experts are used as effectively as possible. It is also recognized that the ministry's GY experts have a much valued ministry context when teaching. As such, some training courses, whose success is dependent on effectively communicating this unique experience, must continue to be delivered by the MOF.

3. MOE should investigate the option of contracting out the user support function to a private sector agency, which might also offer similar services to industry.
4. A multi-year training and extension plan should direct extension activities.
5. Greater efforts are required to make GY clients aware of GY initiatives and current research.

Modelling Standards and Guidelines for Development, Application, Maintenance and Monitoring

Strategic goal: ***Ensure that accepted standards and guidelines for the development, application, maintenance and monitoring of GY models are developed and communicated to GY clients.***

GY activity is characterized by an absence of explicit and recognizable standards and guidelines. Yet there is considerable uncertainty regarding the role and practicality of developing such standards and guidelines. Some strongly oppose the development of guidelines arguing that further abuses and misapplications of GY modelling are likely. Additionally, many argued that GY modelling remains a very subjective exercise and that guidelines will not change this condition. In opposition, others argued that guidelines are essential to move beyond the "black box" view of GY modelling and to develop approaches that command the legitimacy of MOF and industry alike. We support the latter view because misapplications of the technology, while not immediately apparent, can have significant long term consequences.

Some of the areas and functions where standards and guidelines do not exist are as follows:

- The recertification of specific GY models to be used under particular circumstances such as location and areas, species, silviculture applications, age, etc.
- The process of approving and certifying models for particular usage;
- The process of maintaining the certification, or recertification, of models and applications;
- "Use policies" or "practice codes" governing the use of GY models;
- Performance monitoring processes used to ensure what models, and the data used in them, continue to be relevant; and
- The acceptance and approval of specific yield curves.

GY modelling efforts have survived in the absence of such standards and guidelines processes. However, its increasing importance to the forest managers of the 21st century will require that these critical processes be documented in a formal way.

Recommendations:

1. Establish certification processes for GY models and development of yield curves.
2. Develop standards and guidelines to address species, geographic limits, treatments, and resolution (age classes, individual stand densities etc.)
3. Develop "use policies" for current GY model to ensure that models are wisely/appropriately used (Prognosis "use policy" can serve as an instructive model).
4. Establish monitoring procedures to ensure that GY tools are periodically evaluated and "recertified."

Priorising and Scheduling the Strategic Directions

The elements of the entire strategy have been priorised over a five year period, shown in chart form on the next page. It is anticipated that these priorities will be confirmed and refined over the coming months.

GY Modelling Strategy

Proposed Priorities and Implementation Schedule

	Ranking	1997/98	1998/99	1999/00	2000/01	2001/02
ORGANIZATION, ADMINISTRATION, LIAISON						
1. Formalize GY Program	B					
2. GY Communication Strategy	B					
3. Define Role of Working Groups	C					
4. Extend Planning Horizon (10 - 15 years)	C					
5. Develop Formal Business Plan	D					
RESOURCES						
1. Secure Long-term Funding	A					
2. Promote/Develop Partnerships	B					
3. Promote Coops as Means to Pool Resources	C					
4. Attract Required Skill Sets	C					
5. Seek out Broader Skill Sets	D					
MODEL APPLICATIONS						
1. Document Required Outputs for GY Models	C					
2. Develop & Implement Criteria for Prioritizing Needs	C					
MODEL INPUTS AND DATA REQUIREMENTS						
1. Identify Model Requirements	C					
2. Identify "end-state" for Data Base	C					
3. Develop Criteria for Prioritizing Data Needs	B					
4. Corporate Approach to Data Collection & Storage	C					
MODEL DEVELOPMENT, PROCUREMENT AND OPERATIONALIZATION						
1. Formalize Development/Procurement Process	D					
2. Environmental Scan - For Models	D					
3. Certification Process and Role of FPC	D					
4. Address Licensing/Liability Issues	D					
5. Investment Criteria	D					
6. Ensure FPC Accomodates Major Models	B					
USER/MODEL INTERFACE						
1. Develop Common Architecture for GY Models	D					
2. Conceptualize Modelling System	D					
3. Simplify Interface for Specific Models	C					
TRAINING						
1. Increase Level of User Training in the Field	A					
2. Identify Training Needs	C					
3. Develop Stand Alone GY Training Module	C					
4. MOF Reduce Level of Direct Involvement in Training	D					
5. Promote Knowledge Transfer	A					
EXTENSION AND USER SUPPORT						
1. Establish User Support Function	B					
2. Keep Operations Informed on GY Developments	A					
3. Investigate Option of Contracting Out	D					
4. Develop Multi-year Training and Extension Plan	A					
STANDARDS AND GUIDELINES						
1. Certification for GY Models & Yield Curves	C					
2. Species, Geographic Limits, Treatments, Resolution	B					
3. Use Policies	B					
4. Monitoring	A					

Key	Ranking			D	C	B	A
	colour code						
	amount of program emphasis		none	low	mod.	High	max.

Next Steps

Growth and Yield is at a threshold in BC. The GY community has been quick to take up many of the merging challenges already but cannot yet ensure strong program coordination, responsiveness and effectiveness in this climate of shifting responsibilities, interests, and needs. We believe the GY modelling Strategy presented represents a departure from, and an improvement in, the way things get done.

The strategy presented here represents one of the first of many steps in the implementation of change. The real effort is yet to come, but come it must if the GY program and related activities are to meet the rapidly emerging needs of the managers of the forest resource throughout the province.

For the immediate future, the following steps are recommended for implementation over the coming months:

1. General acceptance by the GY Steering Committee of the recommendations comprising the GY modelling strategy and the preliminary estimates of timing;
2. Summarization and presentation to the Chief Forester and the FPC, together with preliminary estimates of timing and resources;
3. General approval of the FPC and the Chief Forester;
4. Development of a detailed implementation plan, overseen by the FPC on behalf of the Chief Forester;
5. Establishment of a GY Modelling Group to assist in developing an implementation plan;
6. Publication and distribution of the implementation plan; and
7. Implementation of the plan over a five year period.

* * * * *

We appreciate the opportunity to conduct this work on behalf of the Ministry and look forward to providing further assistance during the implementation of the strategic recommendations.

FORUM Consulting Group
Victoria, BC
November 1997

Growth and Yield Program
Steering Committee,

Ministry of Forests

A Growth and Yield Modelling Strategy for British Columbia

DRAFT

November 1997

FOREST RENEWAL BC

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November 1997

The Growth and Yield Program Steering Committee
Ministry of Forests
Third Floor, 31 Bastion Square
Victoria, BC
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Gentlemen,

We are pleased to enclose our report entitled "A Growth and Yield Strategy for British Columbia."

We have concluded that the external strategic pressures over the past few years have had the effect of significantly increasing the importance of GY to the continued development of the forest resource and, accordingly, the reliance placed on GY modelling in forest planning and management. Although great strides have been made in the past few years, the Ministry of Forests is not yet in a position to adequately serve the current and emerging needs of its users without significant changes being made to way it supports and implements GY modelling initiatives and activities.

This report constitutes a positive step towards satisfying current and emerging needs of GY model users at the same time as dealing with an era of reduced financial circumstances. The strategic recommendations it contains will be challenging to implement and, we expect, will generate a certain degree of controversy. Nevertheless their development and implementation will be essential if future forest management needs are to be properly addressed.

Although focussed on GY modelling, the proposed strategy also addresses GY issues broader in scope. These broader issues are addressed because they significantly affect GY modelling and the existing capacity to serve model users. Consequently, the implementation of the GY modelling strategy requires the commitment and cooperation by those responsible for developing, implementing and administering the broad GY Program in BC.

We would like to recognize the guidance of the GY Program Steering Committee in the development and implementation of this study and the contributions of the many individuals and organizations who provided information to us during its course. We appreciate the opportunity to conduct this work on behalf of the Ministry of Forests.

Yours very truly,

Forum Consulting Group
Chris F Jones, CA MBA CMC, Partner

Strategic Highlights

We have concluded that the external strategic pressures over the past few years have had the effect of significantly increasing the importance of Growth and Yield (GY) to the continued development of the forest resource, and the reliance placed on GY modelling in forest planning and management. Although great strides have been made in the past few years, the Ministry of Forests is not yet in a position to adequately serve the current and emerging needs of its users without significant changes being made to the way it supports and implements GY modelling initiatives.

This report constitutes the first step in what will doubtless prove to be a long and sometimes arduous process to satisfy the current and emerging needs of GY model users in government and industry at the same time as dealing with the reality of reduced financial circumstances. The strategic recommendations contained in this report will be challenging to implement and, we expect, will generate a certain degree of controversy. Nevertheless their development and implementation will be essential if future forest management needs are to be properly addressed.

This review was originally designed to investigate and provide recommendations on strategic issues and user needs in the comparatively specialized field of GY modelling. However, early in the implementation, it became evident that the modelling issues could not be addressed properly outside the context of the Ministry GY program. To some degree, they must also reflect the extensive GY activities undertaken outside the Ministry – in industry, in co-ops, in consulting firms and in educational institutions. Accordingly, the review process was expanded in its scope in order to recognize more adequately the diverse operating context and community of which GY modelling is but one component.

In consequence, our recommendations are relatively broad-ranging and deal with a wide spectrum of nine issue groupings which confront the GY model user in the field – from Ministry GY organisation through data issues, modelling, extension and training. But they fairly reflect what we found and what users told us they were concerned about.

We are aware that our recommendations need considerable development and refinement before they can be implemented and we caution the reader not to view this report as the final, or even the draft, "implementation plan." There are many key players and organizations that are directly and indirectly involved in GY modelling throughout the province and it will be important to gain the confidence of the majority of them, if not all of them, before embarking on the implementation of any of the strategic recommendations.

During our review, the BC Forest Productivity Council was re-constituted and new members were appointed. We view this development as a strong indicator of the province's confidence in the co-operative approach to forest productivity enhancement and an essential step in the development of the GY organisation, technology, applications and knowledge development which will be needed for the next century. We also see the new Council as the main instigator, and the logical leader, in the implementation and monitoring of many of the GY modelling strategies recommended in our report. To this end, we support the establishment of a strategic implementation task force as a technical committee, reporting to the FPC, which will monitor and report progress. In addition, we strongly support a significant degree of independence for the FPC, which can only be assured by access to funds to conduct appropriate management (not necessarily technical) research and analytical work on its own account. This, in turn, would require a multi-year funding commitment, most likely through FRBC, the only available source.

Our proposed strategic goals and recommendations are summarized below:

Organisation, Administration and Liaison

Proposed Strategic Goal: ***Ensure that the organisational framework for GY allows for the development of "corporate" approaches to GY and engenders long-term support for GY modelling activities in BC.***

Recommendations:

1. Formalize the GY program and design and document it according to accepted program design principles. Twelve commonly accepted program design principles are presented in Chapter 6.
2. Develop a new GY communication strategy (including a GY modelling communication strategy) to convey program and strategy details and current initiatives. This strategy serves a two-fold purpose by raising awareness and managing expectations related to GY modelling.
3. Continue to use working groups, Co-ops and TACs which have the support of the provincial GY community to undertake well defined, problem oriented projects or tasks. As such these bodies must be:
   - assigned specific terms of reference which:
     - define the problems;
     - explicitly link projects to problems;
     - identify project terms;
     - are limited as to duration; and
     - identify project deliverables.
   - comprised of members from each of the agencies with an interest in a particular initiative; and
   - guided by formal project plans. (The Prognosis BC approach serves as a model for future working group activities.[1])
4. Operate the GY Program under a 10 to 15 year planning horizon to ensure that plans to meet short and long term goals can be properly developed and implemented and that an appropriate balance is maintained between them.
5. Develop a formal business plan for each one to three year "rolling" planning period.

Resources to Support the GY Program

Proposed Strategic Goal: ***Secure sufficient resources (including funding, skills and personnel) to pursue GY initiatives of strategic importance in a timely manner.***

Recommendations:

1. FRBC should commit long-term funding to support the GY program in BC. A suggested funding arrangement is to establish an annuity with a term of ten to fifteen years (which is reviewed every 3 to 5 years). The annuity should ensure that current annual expenditure levels are maintained and, if possible, enhanced. However, long-term continuity of funding may be as important as its actual level, since many GY projects are long-term in nature.
2. Partnerships between industry, MOF and academia should be promoted as a means to effectively implement and advance the province's GY program and GY modelling. In this regard, greater consideration should be given incentives that promote industry participation in GY. (Without sufficient incentives, continuing commitment to the newly constituted FPC, and GY generally, cannot be ensured.)

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[1] Ministry of Forests (nd.). *Prognosis BC*.

3. Co-ops should be promoted as one of the key mechanisms to pool resources between industry, MOF and academia. (Co-ops may be funded through FRBC and industry contributions.)
4. Long-term funding should be used to attract people with required skill sets, alleviating some pressure to develop skill sets locally through academic institutions, industry and the Ministry.
5. Seek out staff with broader skill sets rather than narrow model-specific GY expertise. Acquisition of a generalized skill set enhances adaptability of staff and promotes a more efficient use of human resources.

Model Applications

Proposed Strategic Goal: ***Ensure that application related needs are identified and priorized.***

Recommendations:

1. Document required outputs for tree and stand simulators for each of the client groups.
2. Develop and implement formal criteria for priorizing modelling needs for each of the major client groups. As a starting point, a series of matrices should be developed which cross reference the major commercial species with stand type and management issue (forest health, silviculture treatments, setting AACs etc.). Key indicators for priorizing each intersecting point could include hectares covered, silviculture expenditures, time available and time required to address problem and expenditures. Areas of greatest strategic importance can then be identified along with an assessment of the current capacity to model them.

Model Inputs and Data Requirements

Proposed Strategic Goal: ***Ensure that model inputs and required data are being collected to use GY models.***

Recommendations:

1. Model requirements should be identified and documented prior to establishing data requirements.
2. An "end-state" for the database supporting GY modelling must be articulated in order to identify data gaps. These gaps are likely to vary in the short term as compared to the long term.
3. Formal criteria for priorizing data needs should be developed for each of the major client groups.
4. Promote the development of an integrated, coordinated, corporate approach to data collection and storage is essential.
5. Encourage the GY Co-ops as essential players in the continued development of the province's corporate data system.

Model Development, Procurement and Operationalization

Proposed Strategic Goal: ***To provide specific GY models that meet the needs of clients.***

Recommendations:

1. Formalize the development/procurement process by including the following explicit functions:
   - Identify the business gaps (what we need versus what we have);
   - Articulate the business need;
   - Scan for existing models (BC and elsewhere) which will meet the business need;
   - Build only if there is no appropriate model to buy;
   - Address the data issue refit and validation;
   - Address the data issues re model operation; and

- Develop and articulate the strategies for
  - procurement versus building models,
  - data, and
  - operationalization.

2. Conduct an ongoing scan of models used in BC and identify models which could be used in BC. Review should be undertaken by the FPC through an appointed TAC.
3. Models selected for use in BC should be approved and certified for use by the FPC.
4. Licensing/liability issues for GY models must be identified clarified and addressed as part of the model development; procurement and operationalizing process.
5. Criteria for investment in GY models should be established and should include costs, business plan, technical requirements; risk management issues and data availability.
6. Prognosis, MGM SPS; TASS, TIPSY, Y-Xeno etc. must all fall into FPC approved strategy.

User/Model Interface

Proposed Strategic Goal: ***Develop and maintain a user/model interface that is menu-driven, user friendly and easy to understand.***

Recommendations:

1. A common architecture should be developed for GY models used currently. This architecture would be corporate in nature, housing inventory; silviculture and timber supply models.
2. Prior to developing this architecture there is a need to conceptualize a modelling system with a decision key that allows identification of model(s) appropriate to specific needs.
3. Simplify interface for specific models. When feasible, a Windows format should be developed with sufficient depth to allow users to understand implications of approaches.

Training

Proposed Strategic Goal: ***Improve the skills of GY practitioners and clients to ensure that appropriate and optimal use is made of existing GY models.***

Recommendations:

1. A concerted effort should be made in the shorter term to increase the level of user training for GY users in the field.
2. A training needs study should be implemented to identify the specific training requirements.
3. A "stand alone" GY training module for foresters should be developed to meet the needs, based on the current SIBC Module 3 curriculum, and offered independently of other SIBC courses.
4. The module should be delivered through SIBC, using private sector trainers where possible and/or the facilities of the Forests Continuing Studies Network.
5. MOF should reduce its direct involvement in the delivery of GY training Courses.
6. In the longer term, the FPC should promote additional GY knowledge transfer through degree granting institutions. This might include:
   - Establishment of GY training as a mandatory component in a B.Sc. degree in forestry;
   - The attraction of graduates in quantitatively oriented degree courses such as computer science and engineering to work in the forest GY field; and
   - Providing strong support for financial resources needed to implement GY training where there is a need.

Extension & User Support

Proposed Strategic Goal: ***Improve GY clients' level of awareness of GY program and initiatives and provide user support at levels which ensure that optimal use is made of existing GY models.***

Recommendations:

1. A user support function should be established to provide assistance to GY users in the field. The service should include quick advice on the GY models approved for use, including the advantages and disadvantages of the use of specific models in the circumstances identified by the user.
2. GY users in the field should be kept up to date on GY developments taking place in the MOF head office, or in other areas, which affect them directly or indirectly. The best way to do this would be through the MOF internet service.
3. MOF should investigate the option of contracting out the user support function to a private sector agency; which might also offer similar services to industry.
4. A multi-year training and extension plan should direct extension activities. Greater efforts are required to make GY clients aware of GY initiatives and current research.

Modelling Standards and Guidelines for Development, Application, Maintenance and Monitoring

Proposed Strategic Goal: ***Ensure that accepted standards and guidelines for the development, application, maintenance and monitoring of GY models are developed and communicated to GY clients.***

Recommendations:

1. Establish certification processes for GY models and development of yield curves.
2. Develop standards and guidelines to address species, geographic limits, treatments, and resolution (age classes, individual stand densities etc.).
3. Develop "use policies" for current GY models to ensure that models are wisely/appropriately used (Prognosis "use policy" can serve as an instructive model).
4. Establish monitoring procedures to ensure that GY tools are periodically evaluated and "recertified."

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FORUM Consulting Group
Victoria, BC
November 1997

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1. Introduction

1.1. Background

> *Growth and yield; coupled with forest inventory, provides the information base upon which Forest planning and investment strategy rests. Forest inventories provide data on the land base area and the volume of timber on it. A coordinated growth and yield program provides estimates of the rate of forest growth for those stands that have received silvicultural treatments and those untreated stands of natural origin. These necessary measures provide the means to estimate the future yield and quality of the forest under any resources management regime.*[2]

GY models are essential in predicting the growth of the forests. These tools have become operational only in the last decade and most advancements in this area have occurred within the last five years or so. In this time, GY models have quickly been delivered to the operational levels and are now used by silviculture planners, timber supply planners and inventory specialists.[3]

Growth models are presently used to support several kinds of decisions including:

- timber supply or allowable harvest decisions – how does growth and yield affect timber supply through time?
- silviculture planning – how will specific treatments affect forest growth?
- program monitoring – which silviculture treatments are effective?
- inventory – what is the current and projected forest inventory?

Models designed for operational use include WinSTIM (Stand and Tree Integrated Model), SPS (Stand Projection System), Y-XENO, Prognosis and WinTIPSY (Table Interpolation Program for Stand Yields), a derivative of TASS (Tree and Stand Simulator). For inventory estimates and inventory projection, VDYP (Variable Density Yield Prediction) has been predominant. TIPSY and VDYP have seen the greatest use while Prognosis is expected to be more widely used following its implementation in the fall of 1997. In addition to these models, a new mixed wood growth model called MGM (Mixed Wood Growth Model) is being developed through the WESBOGY (Western Boreal Growth and Yield Co-operative), in which MOF participates.

The potential impacts of significant errors in GY projections are becoming greater as demands on the forest resource increase. Thus, the importance of accurate GY analysis is increasing rapidly. At the same time, the resources available to design and conduct GY analysis, at least in government, cannot always keep pace with increasing demands and so choices have to be made between activities to ensure that the best values are received for the investments made in GY activities.

Growth and Yield activities are undertaken by the Ministry of Forests, the forest industry and the consulting community. Of these, the Ministry of Forests GY program has been the most significant in terms of funding and level of activity. At present the MOF GY program is "shared" among three branches – the Resources Inventory Branch, the Research Branch and the Forest Practices Branch. The GY activities of these three branches are coordinated through the Growth and Yield Steering Committee whose chair reports directly to the Chief Forester.

Province-wide, GY programs and activities are coordinated and guided by the Forest Productivity Council which sets the overall strategic direction for GY in the province. The FPC is comprised of MOF, industry, independent GY consultants and industry associations. A Technical Advisory Committee supports the

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2 Secretariat, Forest Productivity Councils of British Columbia (March 1991). *Growth and Yield Program Plan 1991–1995*. Victoria: Inventory Branch, Ministry of Forests.

3 Initially, models were developed for research purposes. In BC, the most significant research model is TASS (Tree and Stand Simulator) which was developed by the Forest Productivity Decision Support Section of the Research Branch (MOF).

FPC and has representation from the same groups. The MOF aims to support strategic directions identified through the FPC in its GY program. The total GY effort, if measured in terms of expenditures, is presently about $12 million annually.[4] In the MOF, there are over 50 FTEs devoted to GY. At present, most GY activities are funded through FRBC.

Following administrative changes made to the Ministry of Forests' GY program in 1993, efforts were undertaken to develop a 5 year strategic plan to direct and guide the Growth and Yield program. The development of a GY Strategy continues to be a high priority. Within the area of Growth Projections (one of the five project areas for the GY Program) the need for a GY model development strategy has been given the highest priority in the short term.[5]

1.2. Terms of Reference

In December 1996, FORUM Consulting Group was invited to develop on behalf of the Ministry, Forest Renewal BC (FRBC) and the Forest Productivity Council (FPC) a strategy for Growth and Yield Modelling in BC which ensures that:

- User needs which are not currently satisfied are identified and priorised so that their priority needs can be addressed first;[6]
- The best use is made of existing GY models;
- Funding and resources can be employed most effectively to meet priority user needs;
- Future needs are anticipated and explicitly planned for; and
- Agencies can coordinate their programs for model development.

The terms of reference are consistent with the Ministry of Forests' view that "user needs should drive application development which should in turn drive research priorities."[7]

1.3. Program Context of GY Modelling

It is intended that the resulting modelling strategy document will be used by the Ministry's GY program, the Forest Productivity Council, Forest Renewal BC and the proposed Growth and Yield Co-operatives to help priorise their programs, improve project and data coordination between the various user groups, rationalize their budgets and allocate resources to projects with the highest priority. The GY modelling strategy is expected to contribute to a broader GY Strategy currently under development.

It was recognized early in the review process that a viable modelling strategy would need to encompass many aspects of GY which, while not directly related to the MOF modelling function, were viewed as critical to the success of the modelling strategy. Accordingly, the review encompassed GY issues such as program redesign, organisational reform etc. when they were seen as having a significant impact on the course of GY model development.

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4 This figure includes wages. (Source: *Forest Productivity Council – Annual Report, 1995/96).*

5 *Ministry of Forests (September 22 / 995), Ministry of Forests Growth and Yield Program – Program Strategy (Draft); p. 15.*

6 Initially, models were developed for research purposes. In BC, the most significant research modes is TASS (Tree and Stand Simulator) which was developed by the Forest Productivity Decision Support Section of the Research Branch (MOF).

7 Ministry of Forests (September 22 1995), *Ministry of Forests Growth and Yield Program – Program Strategy (Draft),* p. 15.

1.4. Review Process

The modelling strategy was developed through a six-phase process. In phase one, a literature review and a series of interviews were conducted to develop a profile of the GY program,[8] the program context and the broad strategic areas that the GY strategy should focus on. In the next phase, over 50 model users and experts were consulted to identify specific needs and the broader issues which affect GY modelling. The following themes were used to focus the discussions:

- organisational. administrative and liaison;
- resources to support the GY program (funding, staffing, skills);
- model applications;
- model inputs & data requirements;
- model development, procurement and operationalization;
- user/model interface;
- training;
- extension/user support; and
- modelling standards and guidelines for model development, application, maintenance and monitoring.

In the third phase, the results of these interviews were compiled and assessed in order to examine which needs were being addressed, which were most vital to ensuring that progress continues to be made where it is most needed, and what would be needed to effectively respond to the needs of users given current threats and opportunities posed by the broader environment of the GY program. Where weaknesses were identified by users, we then reviewed the existing efforts of the Ministry to address them.

In the fourth phase, we attended a half-day meeting with the managers responsible for the Ministry of Forest's GY program to review our initial findings and assessments.[9] The consulting team then met as a group to develop the strategy and to document the findings and recommendations contained in this report.

In the fifth phase, managers responsible for the Ministry's GY program priorised recommendations made in this report.

In the sixth phase, the draft report was distributed to some 70 people working in the field of GY in government, industry and academia. They were invited to comment on the draft and to priorise recommendations made in the report. Comments and input received were used to refine the GY modelling strategy.

1.5. Limitations and Scope Restrictions

There are a number of limitations and restrictions to the scope of the GY modelling strategy study that should be considered.

- The GY client group is growing quickly and we spoke with a selection of clients who were among the most informed users; but we did not attempt to consult all of them.
- The study is intended as a starting point and, as such, it is not presented as a formal "GY Modelling Strategic Plan" for BC. It should be considered as a discussion paper that will require additional consultation and development.

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[8] FORUM Consulting Group (February 1997). *A Profile of Growth and Yield Modelling in British Columbia (Study of Growth and Yield Modelling Strategy in British Columbia – Background Paper No. 1)*. (prepared for the Growth and Yield Program Steering Committee, Ministry of Forests).

[9] This meeting was attended by Barrie Phillips, (Research Branch, Steven Steams-Smith (Research Branch), Jon Vivian (Resources Inventory Branch), Ralph Winter (Forest Practices Branch), Don Reimer (D. R. Systems), and Forum Consulting Group.

- A comprehensive review of GY models available in other jurisdictions was not conducted. The study focused on those models currently in use or models with advocates in BC currently.

1.6. Report Outline

This report is organized as follows:

Chapter 2 presents an overview of the strategic operating environment of the GY program;

Chapter 3 presents a description of the Ministry's Growth and Yield Program, modelling related activities pursued through the program, and an overview of the organisational context within which the GY program exists;

Chapter 4 identifies the linkages that exist between GY modelling activities and organizations;

Chapter 5 presents an overview of the main GY modelling issues which the Ministry of Forests currently confronts, and user needs in relation to these issues; and

Chapter 6 presents the strategic directions proposed for GY modelling and the rationale for each of them.

Chapter 7 reports the results of a first level priorisation process involving members of the GY community.

Chapter 8 identifies the next steps required to implement the GY modelling strategy.

1.7. Acknowledgements

We would like to acknowledge the important contributions made to this review by the persons listed in Appendix 1, especially the extensive input of the GY Steering Committee. We also acknowledge the contribution of Dr. Don Reimer of D.R. Systems Inc., whose background knowledge of GY and association with the Forest Productivity Council were invaluable to our appreciation of the issues addressed. The conclusions and recommendations, however, are those of FORUM Consulting Group.

2. Strategic Operating Environment

There are an array of environmental factors which present constraints, opportunities and threats to the GY program. Some of these factors may be found within the GY program while others are external to it. The linkage between these factors and the GY program has been succinctly described by the Ministry of Forests. They state,

> *The objective of the Growth and Yield Program is to provide the growth and yield tools and information needed by (our) clients to manage the provincial forests. Forest managers plan and implement activities based on the application of growth and yield information. The Growth and Yield Program develops that growth and yield information. Forest management activities are based on social expectations, and since social expectations change, the needs of forest managers also change, creating a need for continuing development of growth and yield tools and information based on social expectations.*[10]

Modelling has left the domain of the researcher and entered the hands of the planner and operational level staff person. With this transition, operational needs are exerting greater influence on the overall direction taken in modelling. There are several environmental factors which have an impact on GY development and model users. New provincial initiatives such as the Timber Supply Review (TSR), Forest Practices Code, strategic level land use planning and the Protected Areas Strategy, new forest management approaches and the trend toward collaborative ventures and joint program delivery[11] have each placed new demands on models and vastly increased interest in, and the importance of, GY activities throughout the province. Market trends, the need to maintain or increase levels of forest-related employment and the period of fiscal restraint that government has entered are also having an impact.

At the same time, tree species which have historically been of little commercial value are now growing in importance. For example, relative to the historically dominant commercial species, there is limited growth and yield information about aspen or aspen/spruce stands. The protection of biodiversity, wildlife habitat and other values related to the forest has become a greater concern in forest planning. In terms of Growth and Yield, these concerns have increased demand for modelling approaches that can handle these additional factors.

These are all external factors over which the GY program has little control and they occur in a decision making environment where scientific knowledge is incomplete.

They are causing greater focus to be placed on improving the confidence levels in inventory estimates and inventory projection and to better understand growth and yield implications of new silviculture systems and treatments. This in turn is leading to an increase in both the demands for GY models and the diversity of situations that model users need to explore.

2.1. Timber Supply Review

The Ministry of Forests' Timber Supply Review program was developed to respond to the need for up to date information on the timber supply to enable a review of allowable cuts across the province. The objective of the TSR was to identify the consequences of current forest practices and management objectives on short and long-term timber supply.

In December 1996, the chief forester completed the setting of new AACs for the province's 37 timber supply areas and 34 tree farm licences. In 32 of these management units, AACs were reduced while the

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[10] Ministry of Forests (September 22 1995), *Ministry of Forests Growth and Yield Program – Program Strategy*, p. 4.

[11] Strategic level land use planning includes Land and Resource Management Planning (LRMP) and the CORE initiated regional planning initiatives that continue to unfold.

AAC was increased in 19 units and remained unchanged in 20 units. Overall, the provincial AAC declined slightly.[12]

The impact of this reduction is more significant to some regions than others but all are faced with declining supplies of coniferous sawlogs. The Nelson and Vancouver Region saw the greatest reductions. The AAC was reduced by over 9% in the Nelson region and over 6% in the Vancouver Region. Conventional coniferous sawlog components of the harvest declined in every region and province-wide by more than 5%. Deciduous and lower economic value components have increased. By December 31, 2001, new AACs will again be determined for all 34 TFLs and 37 TSAs. AACs are expected to continue to decline in many parts of the province.

2.2. Forest Practices Code

The Forest Practices Code came into effect in June of 1995 and enhances protection of forest values including timber, fish, wildlife, water quality, biodiversity, soils, recreation and culture. The new standards will require adjustments to field operations, additional training, improvements in monitoring and enforcement.

The Code is also expected to lead to new demands for forest resource information and further reductions in AACs. Less than half of the 71 AAC decisions fully accounted for the effects of the Forest Practices Code.[13] The MOF recently estimated that riparian and biodiversity requirements could impact harvest levels by 6% over the short term and 10% in the long term. Watershed assessments and Visual Quality.

Objectives can also lead to reductions in timber supply. These impacts are expected to vary in each forest region.[14]

The code is also influencing forest management practices. For example, there has been increased use of shelterwood systems and there has been much more emphasis on identifying expected benefits of silviculture treatments.

2.3. Strategic Level Land Use Planning & the Protected Areas Strategy

Two strategic level land use planning initiatives were implemented in BC in the last few years. Regional level planning was begun by CORE (Commission on Resources and Environment) and sub-regional planning (Land and Resource Management Planning) has also been initiated. The regional planning processes have now been completed and implementation of the plans is underway. LRMP processes are continuing and it is expected that LRMPs will be completed for the entire province by the year 2000.

Strategic level plans are being used to deliver much of the Protected Areas Strategy (PAS) and are used to set strategic direction for planning areas within LRMPs.[15]

The PAS was established in 1992 by the province to protect representative examples of the natural diversity of the province, as well as natural, cultural heritage, and recreational features. The target established for the PAS is to protect 12% of the province by the year 2000. Between May of 1992 and April 1996, 167 new protected areas and/or park additions were created. These new areas totalled over 2.7 million hectares bringing BC's total protected area from 6% to 9.1 6%.[16] The designation of parks has usually been through the reallocation of land from provincial forests to protected areas. This has reduced the total forest land base available for timber harvesting.

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12 Ministry of Forests (1997), *Summary of Timber Supply Review Results 1992-1996.*

13 They were completed before the code was implemented.

14 The MOF also notes that, in some instances, VQOs can lead to a harvest gain (Ministry of Forests (1996) *Timber Supply Analysis).*

15 Ministry of Forests (June 1996).*Ministry of Forests Annual Report.* p. 12.

16 Kaaren Lewis, Susan Westmacott (April 1996). *A Protected Areas Strategy for British Columbia - Provincial Overview and Status Report.* Victoria: Land Use Coordination Office. p. 5.

2.4. Future Market Demand

BC's timber is used to produce a variety of wood products and demand for these products changes. The demand for particular species and quality of fibre is likely to change as a consequence. Although demand for particular wood products in the future is not easily predicted, increasing attention is being paid to managing current forest resources to grow timber of a suitable quality and specific species composition to meet anticipated demands.

Some analysts note that demand for commodity products such as dimension softwood products for basic construction, is expected to grow at much lower rates than for engineered wood products and pressure to produce higher quality and grade products is expected to continue.[17] Shifts in product lines could also lead to shifts in forest management and consequent shifts in demand for GY tools. There is already a demand for timber quality models that is currently not being met.

2.5. New Approaches to Forest Management

Forest managers have been seeking innovative approaches to forest management in response to many of these new initiatives and demands on the forest land base. Notable among these has been the growing support for ecosystem-based approaches to forest management and more intensive silviculture planning to ensure that stand level planning furthers forest level objectives.

2.6. Changing Social Expectations

Over the last several decades, population growth and industrial expansion have intensified pressure on land and resources in British Columbia. Concern over the environmental costs of such expansion have led to bitter conflicts over land and resource use. This has made it clear to government that new approaches to land use management are required. The Forest Practices Code, Protected Areas Strategy and strategic land use planning are some of the more important responses to these conflicts.

Communities have also been concerned over the impact of environmental protection on long term employment levels and the impact of new technologies in forest harvesting and processing. Forest Renewal BC, and the recent *Jobs and Timber Accord* have been significant measures to ensure that the forest industry continues to thrive.

Government has sought to maintain healthy local economies at the same time as protecting fragile ecosystems. The attempt to balance environmental, economic and social goals has placed greater pressure on government to seek out innovative approaches to forest management that can pursue these varied and often conflicting goals. As a result, there has been increased pressure on GY to provide tools and information that reduce uncertainty in decision making.

2.7. "The Truth is Out There" – Increasing Reliance on Technical Knowledge

Many of the most important decisions with respect to forest management, such as setting AACs, are made with imperfect knowledge of the forest land base. In the face of declining AAC's, changes in forest practices and the reallocations of land into protected areas there is increased demand for improved knowledge. Increasing demands are now being placed on the GY program to demonstrate more precisely the GY implications of the many initiatives and management practices now being implemented and to reduce the risk in decision-making.

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[17] Bill Wilson and Roger Ennis (1994), *British Columbia Forest Products Industry, Production, Markets, Competition and Competitiveness*, FRDA II WP-01-94.01. G.E. Bridges & Associates Inc. (March 1997), *Strategic Overview – British Columbia's Northwest Timber Processing Industry*, prepared for FRBC, Skeena-Bulkley Region, Smithers BC and Prince Rupert Forest Region, Ministry of Forests.

A recent example of how improvements in the knowledge base affect decisions related to timber supply is the OGSI (Old Growth Site Index) initiative.[18] OGSI has indicated that growth rates for young stands in many parts of the province may be presently underestimated, and suggest that long term harvest levels may be also underestimated. The GY program is expected to demonstrate the benefits of intensive management in other areas and to generally reduce the risk component of decision making in forestry management.

2.8. Fiscal Restraint in Government

Government has entered a period of fiscal restraint. As a result managers have in many cases seen a decline in the resources available to them to meet outside demands and pressures with respect to forest management. Managers have sought to improve the coordination of programs and to seek out opportunities to deliver programs cooperatively with the private sector to overcome shortfalls in resources. The success of many programs will, as a result, depend upon the extent to which co-operative relationships can be maintained between organizations with a stake in particular programs. New administrative arrangements for managing forests in BC are, understandably, being discussed with increasing frequency.

2.9. Conclusions

The GY function is currently operating in a fluid environment characterized by increasing demand for:

- scientific knowledge about the behaviour of forests (including site productivity);
- models which reflect that behaviour;
- site-related data which enables the models to be operated; and
- practical model applications appropriate to the operational circumstances.

At the same time, being funded mainly by government, GY is subject to the financial and resource constraints which affect government funded operations throughout the province.

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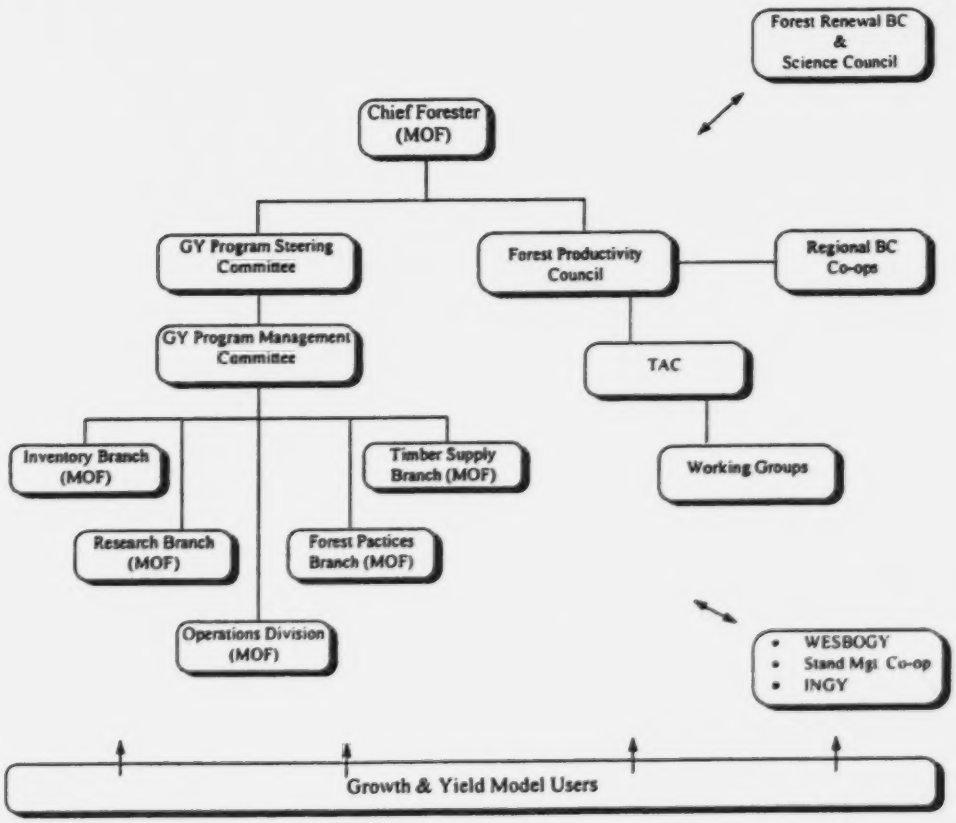
[18] Larry Pederson (April 1997), *"The Truth is Out There"* Chief Forester's address to the Annual Convention of the Northern Forest Products Association, Prince George, April 3 1997.

3. Organisation of The Ministry of Forests Growth & Yield Program

The broad organisational context for GY includes the Ministry of Forests, industry, academia, the Forest Productivity Council, Forest Renewal BC, nascent Growth and Yield Co-operatives and forestry consultants. The activities of each of these groups have some impact on the other. For example, the Ministry of Forest's GY program is guided by the Forest Productivity Council's GY Strategy, and FRBC has adopted the strategic priorities of the Forest Productivity Council and the Ministry of Forests programs. The key groups and their relations to each other are illustrated below and discussed in this chapter.

Principle Groups Involved in GY Modelling



3.1. Growth and Yield Program Activities

There are live main activity areas pursued through GY as follows:

1. Program administration and liaison
   - extension activities
   - liaison with other agencies
   - rationalizing data management
2. Site productivity assessment
   - development of growth intercepts
   - development of site index curves
   - site productivity estimates
   - site index adjustment project for old growth
3. Permanent plots & growth installations
   - rationalization of data needs with model development
   - establishment of monitoring program
   - field measurements (PSPs and EPs)
4. Tree and plot damage assessment;
   - volume and decay projects
5. Growth projections.
   - estimating forest health impact on yield
   - developing tools for projecting new inventory
   - non timber resource modelling
   - modelling of complex stands
   - value and quality modelling

This study focusses on the activities included in component 5 – Growth Projections. However, we were obliged to review and consider several of the other activity areas in the course of the study.

3.2. Growth and Yield Program Expenditures

Resources allocated to GY activities have increased sharply in recent years. As noted in the table below, expenditures in 1995/96 exceeded $12 million. The expenditure data is presented as reported in the Forest Productivity Council's annual reports. Figures reported in annual reports are for cooperating agencies which include forest companies, Canadian Forest Service, Ministry of Forests and UBC. Prior to 1993/94, the reported totals did not include wages. Total program expenditures excluding and including wages are included for comparison. Expenditure estimates provided by the Forest Productivity Council's data provide a reasonable indication of GY expenditures over the years.

Growth & Yield Program Expenditures by Fiscal Year: 1988/89 to Date ($000)

Fiscal Year	Administration, Systems & Liaison	Productivity Assessment	Permanent Plots and Growth Installations	Tree and Plot Damage Assessment	Growth Projections	Total (excluding wages)	Total (including wages)
1988/89	–	–	–	–	–	982.10	
1989/90	70.00	417.60	629.80	89.00	376.00	1,582.50	
1990/91	451.40	603.80	1,388.60	329.80	589.70	3,363.30	
1991/92	467.50	850.60	2,827.50	554.00	625.00	5,324.60	
1992/93	933.50	540.00	2,260.30	363.80	666.80	4,764.40	
1993/94	778.30	305.50	3,555.10	816.80	873.20	6,328.90	10,058.90
1994/95	1,129.10	1,121.40	3,599.80	542.40	1,189.80	7,582.50	11,785.30
1995/96	1,164.90	1,113.00	4,440.40	630.30	907.80	8,256.40	12,246.40

3.3. Development of a Coordinated Ministry of Forests Growth and Yield Program

One of the first steps to coordinate GY activities was taken by the Chief Forester in 1992 with the formation of a GY strategy team to:

- Ensure the MOF Growth and Yield Program is coordinated and integrated across organisational units and that it meets the needs of all users in both the short and long term;
- Increase the level of knowledge and expertise in the use of growth and yield information in the Forest Service; and
- Ensure Growth and Yield Program users apply the best available information in a consistent and technically correct manner.

The GY Strategy Team's efforts culminated with the 1993 Mesachie Lake workshop where a series of recommendations were made to the Chief Forester to unify and improve GY efforts. In response, the Chief Forester formed the Growth and Yield Steering Committee consisting of representatives from the Resources Inventory Branch, Research Branch, Silviculture Practices Branch and Timber Supply Branch. This committee continues to meet regularly. A Growth and Yield Program Plan was drafted in 1995 and is currently under revision.

Prior to the coordination of the GY program it was acknowledged that there existed institutional barriers hindering efforts to coordinate a Ministry-wide GY program. Each of the branches which maintained some responsibility for GY efforts tended to pursue branch-specific programs in the absence of a coordinating mechanism within the Ministry.

3.3.1. Ministry of Forests

The Ministry of Forests Growth and Yield Program is a coordinated, inter-branch program consistent with the Forest Productivity Council's current Growth and Yield Program. The MOF's program guides GY activities in three branches – the Resources Inventory Branch, Research Branch and the Forest Practices Branch. The Timber Supply Branch is also an important participant but primarily as a user of systems developed and implemented in the other branches. These four branches are part of the Forestry Division for which the Chief Forester is responsible and their GY activities are coordinated through a GY Program Steering Committee (GYPSC). The Forestry Division, in turn, is one of the four divisions into which the Ministry of Forests is divided. The Operations Division is the operating arm of the ministry and is responsible for implementing ministry policy. They use systems and tools developed through the GY program and play a leading role in data collection. In sum, activities pursued through the GY Program are expected to contribute to the achievement of branch, division and ministry wide objectives.

Chief Forester

The Chief Forester, an assistant deputy minister, is responsible for the six branches in the Forestry Division – the Timber Supply Branch, Forest Practices Branch, Resources Inventory Branch, Research Branch and the Forestry Division Services Branch.[19]

The Forestry Division is responsible for providing the policy framework, technical standards, tools, procedures and support for field staff to manage all aspects of the forest management cycle.[20] Of these six branches, three have responsibilities for GY modelling and are guided by the Ministry of Forests' GY program. These are the Resources Inventory Branch, Research Branch and the Forest Practices Branch. The activities of these three branches are discussed separately below.

Resources Inventory Branch

The mission of the Resources Inventory Branch is to provide:

- Current, comprehensive, accurate and consistent, ecologically based inventories of the forest resources of British Columbia;
- Efficient access to the forest resources information;
- Information in support of integrated resource management decisions;
- Compliance with government wide inventory and data management standards, and,
- Training, planning and application development in response to client needs.

The Resources Inventory Program finds its mandate in Sections 2, 3 and 4 of the *Forest Act*. Historically, the Resources Inventory Branch has had responsibility for modelling *natural* stands. In this endeavour, VDYP has been the predominant model. Prognosis has also received some attention from the branch and has been used in trials.[21]

Research Branch

The Research Branch traditionally was responsible for the GY modelling of *managed* stands.[22] The Forest Productivity and Decision Support Section (FPDS) of the Research Branch directs research and development into GY modelling, with input from other ministry staff and industry. Several GY software products have been developed to generate information for planners and silviculturists including:

- SYLVER (TASS, SAWSIM, FANSY)
- TIPSY (WinTIPSY)
- SiteTools
- FredTab
- GRAFLEX

FPDS has developed educational material intended for use by foresters and the public and offers scheduled courses and workshops to support model users.

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[19] The MOF was re-organized in 1995–96. Source: Ministry of Forests (November 1996) *Organization Chart*.

[20] Ministry of Forests, *Getting in Touch*.

[21] Yield comparisons between Prognosis, SPS and TASS have been made for uneven-aged interior Douglas-fir, for example. Most recently, an implementation plan and a validation and calibration plan have been developed by the Ministry of Forests. The MOF expects to implement Prognosis in the fall of 1997 in the Southern Interior region of BC.

[22] The separation of management responsibilities between managed and unmanaged stands is no longer made by the MOF.

Forest Practices Branch

The primary functions of Forest Practices Branch are to:

- maintain the silvicultural elements of the Forest Practices Code;
- provide specialist technical advice to district, region, executive, industry, and other stakeholders; and
- participate in Forest Practices Code audits.

Its core purpose is to create and support innovative practices and products that improve critical thinking and choices of those who plan and shape forests. Therefore, the Forest Practices Branch strives to translate growth and yield information into applications directly linked to silviculture activities. In this regard, Prognosis has been identified as the most promising GY model currently available.[23]

Timber Supply Branch

The Timber Supply Branch is responsible for timber supply analysis which provides some of the most important information used in making AAC determinations. Timber supply analysis uses growth and yield models in conjunction with other planning inputs to drive its forest estate model (developed in 1992) FSSIM. FSSIM is a strategic tool used in making AAC determinations. Other than as a user of the results of GY models, Timber Supply Branch has a limited role in the GY Program.

Operations Division

The Operations Division includes all ministry regions and districts and is essentially the operating arm of the ministry. It is charged with implementing ministry policy and has a leading role in GY data collection. The division uses GY systems and tools in its day to day activities and planning and they look to the Forestry Division for support and the timely development of GY tools and models that meet their silviculture, inventory and timber supply planning needs. As such, the Operations Division provides vital input into the GY Program and ultimately represents the GY program's largest client group.

Growth and Yield Steering Committee (GYPSC)

The Growth and Yield Steering Committee (GYPSC), created in 1993, was established to co-ordinate the MOF's GY Program. The membership of the GY Steering Committee includes Directors and Managers from the Resources Inventory Branch, Research Branch, Timber Supply Branch and Forest Practices Branch. The Operations Division is also represented and a Growth and Yield Extension Officer is a member of the committee.

According to their terms of reference, the GY Program Steering Committee is to:

- Assign priorities and responsibilities for MOF Growth and Yield Program delivery through approval of an annual Growth and Yield Program Plan;
- Secure and allocate funding for implementation of the Plan;
- Review Program outputs and scheduled delivery of approved products;
- Appoint technical experts to review models and "best estimates" produced by the Program; and
- Establish protocols to ensure that growth and yield information is used appropriately.[24]

The GYPSC has also been given responsibility for approving growth and yield products for development and for release to the intended users. Normally the GYPSC will approve projects for release on the

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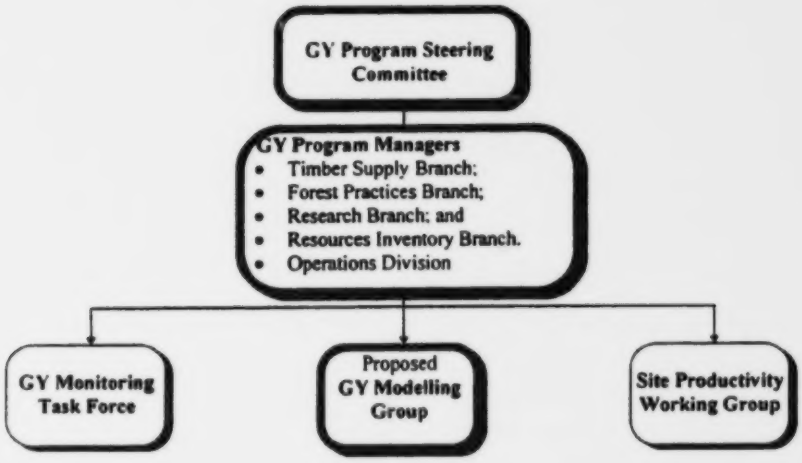
[23] Excerpt from: Henry Benskin, Director, Silviculture Branch, (Nov. 30, 1994) Memo Re: Needs Assessment for the Ministry of Forests Growth and Yield Program.

[24] Ministry of Forests (nd.), *Growth and Yield Program Steering Committee Terms of Reference*.

recommendation of the Growth and Yield Managers.[25] The Steering Committee meets regularly and has organized a number of working groups to address priority areas including a GY Monitoring Task Force and the Site Productivity Working Group. In addition, a GY Modelling Group has been proposed. The committee structure continues to evolve and is illustrated below (current to mid-1997).



It is anticipated that a Growth and Yield Modelling Working Group (GYMWG) would be formed and given responsibility for implementing the Growth and Yield Modelling Strategy. The GYMWG would report to the GYPSC or the FPC and represent the interests of the provincial Growth and Yield Program as established and documented by the Forest Productivity Council.[26]

3.4. Forest Productivity Council of British Columbia

Two Forest Productivity Councils (Coast and Interior) were formed in 1986 to advise the Chief Forester on the acquisition of growth and yield information such as the determination of rates of growth and future yield; and impacts due to insect and disease vectors. The Councils were co-operative bodies, composed of representatives of the major forest associations, the Canadian Forest Service, the Ministry of Forests, forest industry companies and universities. Participating organisations volunteered resources to investigate, analyze and review current efforts and direction in GY.

The Councils served to co-ordinate and guide the efforts of different agencies and developed several five year strategies. Each year, the Councils recommended to the Chief Forester an annual plan of operation and produced an annual report. The two councils were amalgamated to form the Forest Productivity Council of British Columbia in 1996. In 1997, the Council's structure was again modified to improve regional representation in GY activities, streamline its structure and enhance its effectiveness.

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[25] *Growth and Yield Project Approval Process* (December 11 1996).

[26] *Growth and Yield Modelling Working Group Terms of Reference (Draft).* (Dec. 11 1996). (presented at GYPSC Meeting Dec. 11, 1996.)

The Chief Forester continues to place great importance on the recommendations of the Council. Strategies and plans developed by the Council will continue to be used by the Ministry to guide the development of the Ministry of Forests' Growth and Yield Program.[27]

3.4.1. Growth and Yield Co-ops in BC

The establishment of regional Growth and Yield Co-operatives in BC has been endorsed to improve regional representation in the GY Program. Co-operatives would be comprised of stakeholder groups including industry and the Ministry of Forests and guided by the FPC's GY program strategy. It was anticipated that co-ops would be established in the Northern Interior, Southern Interior and on the Coast. Efforts to establish a Northern Interior co-operative have stalled although there continues to be strong interest in its formation. A Southern Interior Growth and Yield Co-operative (SIGY) is presently being formed. There has been little interest in forming a coastal co-op, however. The precise role that regional co-ops will play in GY has not yet been finalized.

The MOF is also a member of three co-ops outside the province:

- WESBOGY (Western Boreal Growth and Yield Co-operative);
- INGY (Inland Northwest Growth and Yield Co-operative); and
- the Stand Management Co-operative.

3.5. Forest Renewal BC

Forest Renewal BC was established as a crown corporation in 1994 and mandated to "plan and implement a program of investments to renew the forest economy of British Columbia by enhancing the productive capacity and environmental values of forest lands, and by creating jobs, providing training for forest workers, and strengthening local communities that depend on the forest industry."[28] FRBC funds its program by reinvesting stumpage fees and royalties from industry.

With the completion of the FRDA II program, FRBC now constitutes the major funding source for GY initiatives. A broad priorizing of GY objectives by activity area was presented in FRBC's 1995 Handbook for Land Based Programs. This priorization is consistent with both the Ministry of Forests' and the Forest Productivity Council's program strategy. However, with respect to GY modelling the priorization scheme is not detailed. The BC Science Council, which evaluates research proposals submitted to FRBC, currently lacks specific criteria for evaluating proposals related to GY modelling, particularly with regard to ranking their importance against proposals for other initiatives and projects.[29]

3.6. Principle Groups Involved in GY Modelling – Summary

The MOF strives to ensure that the direction of their Growth and Yield Program is determined through a co-operative, consultative processes involving many groups. The linkages between the key GY modelling activities and the various organizations are illustrated below. We have identified 14 distinct activities falling into five broad categories and the primary organizations involved in these activities. It will be recognized that the organisational structure governing GY activities in BC is complex.

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[27] T.G. Honer & Associates (January *1993*), *Growth and Yield in British Columbia: 1920 – 1992*. p. *33*. However, it should be noted that the MOF has implemented a Growth and Yield Transition strategy to guide its activities through the restructuring period for the FPC.

[28] Forest Renewal BC (1996), *Research Program Overview*. (contained in Research Program Information Kit).

[29] A recurring issue with respect to funding is the removal of GY from the "A" Budget status in the late 1980's, which has left the funding of GY activities contingent on the availability of funding from non-MOF programs such as FRDA II or FRBC.

TABLE OF RESPONSIBILITIES

		GYPSC/GYPM	GY Modeling WG	Research Branch	Forest Practices Branch	Timber Supply Branch	Resources Inventory Branch	MOF Regions/Districts	Forest Productivity Council/TAC	GY Cooperatives	Forest Renewal BC & Science Council	Universities	Industry, Associations & Consulting Community
Modelling Strategy	1. Assessing need for changes in general direction of modelling strategy	X	X			X			X				
	2. Determining specific client needs		X										
	3. Determination of modelling priorities with regard to financial & resource constraints	X				X			X		X		
Model Development	4. Collecting data to confirm validity of specific models			X	X		X						
	5. Assessing new (to BC) models, components and applications	X		X	X	X	X						
	6. Collecting data to enable operation of models in the field (proving and piloting)			X	X		X	X					X
	7. Approving models for use in specific applications*	X											
Operating	8. Operation of models			X	X	X	X	X				X	X
	9. Assessing the results of a specific field application/operation				X	X		X					
Ongoing Assurance	10. Monitoring (comparing actual GY to predicted GY)				X		X						
	11. Assessing continuing validity of the model's performance			X			X						
	12. Maintaining relevance and practicality of model (eg. incorporating improved data)			X	X		X						
Extension	13. User education and training			X	X							X	
	14. Public education			X								X	

* Modelling applications might include, for example:

- Timber and non-timber resource values;
- Economic values;
- Managed and natural stands;
- Silviculture treatments;
- Harvesting methods; and
- Even and uneven aged stands.

4. A Profile of GY Models Used in BC

Among the many tools used in estimating growth and yield are computer-driven models or growth and yield prediction systems. GY models "synthesize concepts and information in a form that allows foresters to evaluate quantitatively the outcomes of alternative silvicultural practices."[30] Growth and yield was, in fact, one of the first computer applications ever devised.[31]

The Ministry of Forests, over the last several decades has undertaken several significant initiatives with respect to modelling. The first significant effort in BC was the development of the BUSH model over the period 1974 to 1978. BUSH was envisioned as a compatible system of growth simulators which were to be linked to the forest inventory. BUSH was demonstrated to the CARP (Computer Assisted Resource Planning System) management committee. BUSH, although delivered to the MOF, was never used extensively and the CARP program itself was abandoned in the late 1970's.

Two significant initiatives marked the early 1980's. Firstly, the Research Branch assembled a modelling team that would put together the TASS (Tree and Stand Simulator) model. Secondly, taking advantage of refinements made to the Forest Classification made in 1978, the Resources Inventory Branch began development of VDYP. More recently, the Canadian Forest Service developed STIM and the MOF has imported Prognosis from the United States for application in BC. BC has also allocated resources to participate in the development of MGM, coordinated through the WESBOGY co-operative.

Other organizations in BC have also had active modelling programs. These include MacMillan Bloedel, which developed XENO, and Weyerhaeuser. Both industry and the MOF have used SPS to some extent as well.

4.1. GY Modelling Applications

Growth and Yield models have been used in the Ministry for three key applications, namely:

- Silviculture planning
- Inventory; and
- Timber supply planning (e.g. the determination of AACs)

Silviculture Planning: Foresters demand models to predict stand growth. These predictions are required to conduct economic assessments of treatment alternatives, help in selecting appropriate silviculture treatment programs, select the individual sites for treatment, and on individual sites, prescribe the right treatment.[32]

In the Ministry of Forests, attention has been focused on Prognosis predominantly in the Forest Practices Branch and TASS in the Research Branch. The Pacific Forestry Centre has recently developed STIM and in the Pacific Northwest of the US the Forest Projection System (FPS) has been widely used.

Inventory: The Resources Inventory has typically used GY models to update and project the inventory of standing timber volumes. VDYP is the primary tool used in this regard.

Timber Supply Planning: GY models provide outputs which in turn constitute one of the inputs for strategic level planning at the TSA, TFL or other planning area. The Growth and Yield models typically used in this regard have been VDYP and TASS/TIPSY.

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[30] Ian Cameron, Ministry of Forests Research Branch. Quoted from Research Program Application Form submitted to FRBC (FRBC Application #HQ96158RET).

[31] After WW II, Dr. Alan Turing, former leader of the famous Enigma code breaking team, turned his hand to the design of the "universal machine" at Manchester University. By 1953 he had devised an electronic model which predicted the growth of Douglas-fir cones. This was one of the first ever practical applications of the computer to the biological sciences. Forty years on, even with somewhat greater computer power, GY applications still present the forest scientist with difficulties!

[32] Patrick Martin (January 1997). *Support Centre for Stand Growth models. (FRBC Operations Framework Proposal).*

Outputs of GY modelling have also been used in economic modelling, forest health and the modelling of non-timber resources or biological modelling.

Most modelling effort occurs in the Ministry of Forests at the branch level (Research Branch, Forest Practices Branch, Resources Inventory Branch, and Timber Supply Branch) and operations throughout the Forest Regions and Forest Districts. Modelling is undertaken by major licensees including MacMillan Bloedel, Western Forest Products, for example, and in the forestry consulting community. Some activity is also to be found at the various universities involved in forestry.

Table 1 on the following page presents some of the key characteristics of GY modelling systems. The principal models currently used in BC are described in the following paragraphs.

Table 1

Characteristics or Attributes of GY Models

Conditions to which the models might apply

- Unmanaged or managed stands
- Pure species or mixed growth
- Even-age, multi-layer or uneven-age stands
- Suitability for extrapolation in the absence of data
- Focus on *current* yield or *future* yield
- Appropriate focus (inventory update; forest management; treatment response; yield losses to fire and pests)

Application environment

- Hardware environment (PC based?)
- Running costs
- Available documentation
- User friendliness
- Quality of user support (e.g. help line?)

Modelling characteristics

- Model form
- Control of equations at the extremes
- Graph fitting techniques
- Verification against independent data sets (calibration)
- Data base characteristics
- Input requirements (standard data requirements?)
- Output provided

How key factors are accounted for in the equations

- Stand age, density, structure: site quality, treatment, history, geography.
- Use of stratification to recognize significant determinants of yield – results in discrete classes within the stand and separate yield curves for each.
- Risk of loss to pests and fire.
- Period to free-growing.
- Decay, waste and breakage.

4.2. TASS (Tree and Stand Simulator)

The first substantial outputs of the TASS model were managed stand yield tables for coastal Douglas fir in 1985. Throughout the 1980's and early 1990's work continued on TASS, calibrating it for more species. The system continues to be maintained by the Research Branch and has been used intensively in the Timber Supply Analysis conducted for both Timber Supply Areas and Tree Farm Licences. These analyses in turn have been a key input into the decision making process for determining AAC's.

4.3. TIPSY (Table Interpolation Program for Stand Yields)

Following the publication of yield tables for Douglas-fir (Mitchell and Cameron, 1985), Ministry planners requested the development of software that would give them electronic access to yield table information.[33] The original software, known as the Meta Model, was developed for the Ministry by Forests Planning Systems, now part of Reid Collins and Associates. In 1990, Ramsoft Systems Ltd. translated the program language from BASIC to C and restructured it to accommodate the next generation of managed stand yield tables, and to improve the ease and speed of operation. The program was renamed TIPSY and the new product was distributed to forest managers across the province, along with a users guide (Mitchell et all, 1991). Ramsoft Systems Ltd. rewrote TIPSY to Windows format in 1993 (WinTIPSY).

TASS generates the metric yield tables contained in WinTIPSY's database. WinTIPSY retrieves appropriate yield tables from its database, customizes the information, and displays the yield summaries. Yield tables are available for various even-aged coniferous species of commercial importance growing on the coast and in the interior of BC.

4.4 VDYP (Variable Density Yield Prediction)

VDYP was calibrated for coastal and interior species in 1990/91, tested in 1991 and then validated. VDYP has been used extensively in the Timber Supply Review process initiated in 1992 and the most recent version was released in 1994 (version 6.2b). The recent completion of the Vegetation Inventory will likely lead to a major overhaul of the model in the coming years. VDYP was developed for use as an inventory model but has been pressed into service to project future volumes as well. Experts in the Ministry remain uncomfortable with the application of VDYP to project future volumes but, to date, an alternative model has not received operational status in BC.[34]

4.5. Prognosis

In the late 1980's the Chief Forester endorsed a proposal to support the implementation of the Prognosis model for BC. Prognosis was developed in Northern Idaho to model complex stands. Several projects focusing on Prognosis were funded through FRDA II in the early 1990's and, by 1995 the Forest Practices Branch was actively lobbying for Prognosis because they felt it was the only growth and yield tool available that could project complex stands and their future stand structure. Prognosis was released for limited use in BC in 1996. It is expected that Prognosis will be calibrated with BC data for the Southern Interior Region by the fall of 1997 and the MOF is currently proposing a number of projects to further the use of Prognosis in BC.

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[33] This section from: J.K. Mitchell, S.E. Grout, and R.N. MacDonald (Dec. 1995). *User's Guide for Producing Managed Stand Yield Tables with WinTIPSY Version 1.3 under Microsoft Windows*. Victoria, Research Branch, Forest Productivity and Decision Support Section (FPDS), Ministry of Forests, p. 1.

[34] The Resources Inventory Branch has recently secured resources to develop a new Inventory Projection System (IPS) which will eventually supersede VDYP.

4.6. STIM & WinSTIM (Stand and Tree Integrated Model)

STIM was developed through the Canadian Forest Service and supported in part by the BC Forest Productivity Councils. The model can predict growth of a stand from establishment until harvest, starting at any intermediate point for natural or managed stands. Although not designed as a silviculture tool, STIM can be used to make projections of treated stands.[35]

STIM was developed for both natural and thinned stands of western hemlock. It was planned in the future to calibrate the model for other commercial species such as aspen and white spruce. There were also plans to modify STIM to project mixtures of aspen and spruce. However, following the termination of CFS' modelling program, development of STIM has all but ceased. The MOF has formally adopted STIM but, to date, has not developed any plans for its use in BC.

4.7. MGM (Mixed Wood Growth Model)

More recently, the Ministry of Forests has begun to support the development of MGM through the WESBOGY Co-operative. The model is expected to meet emerging demands for mixed wood growth models in BC. The primary focus of the model is on white spruce and aspen. Lodgepole pine and black spruce are also included but less emphasis has been placed on development of relationships for these species. It is expected that Aspen data gathered for development of STIM will be used to calibrate MGM for BC conditions. The MGM model is not yet available for operational use in BC. The application of MGM will be limited to the northeastern portion of BC initially.

4.8. SPS (Stand Projection System)[36]

The Stand Projection System was developed in the US specifically for coastal Douglas-fir and was later calibrated for other species. Several pilot projects were initiated by the MOF to operationalize SPS and, several projects to gather the appropriate data were undertaken. However, over the last few years SPS has fallen into disuse in the MOF. It continues to be used in the consulting community and industry where it has strong support.

4.9. Other Models

MacMillan Bloedel has developed its own GY model called Y-XENO.

4.10. Summary of Model Characteristics[37]

The general characteristics of the main GY models used in BC at the present time are summarized in Table 2. The table demonstrates some of the differences in the models' characteristics and hence their suitability, or lack thereof, for some applications. Table 2 is intended as a general overview of the models rather than an in depth profile.

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[35] G.M. Bonnor, R.J. DeJong, P. Boudewyn and J. W. Flewelling (1995), *A Guide to the STIM Growth Model*. Victoria: Pacific Forestry Centre, Canadian Forest Service.

[36] Secretariat, Forest Productivity Councils of British Columbia (July 1991) *A Guide to Growth and Yield Models of the Pacific Northwest*. Victoria: Inventory Branch, Ministry of Forests.

[37] Note: Table completed with the assistance of Albert Nussbaum (TASS & WinTIPSY), Mike Bonnor (STIM), Ralph Winter (Prognosis), Stephen Titus (MGM), Cam Bartram (VDYP), Steve Northway (Y-XENO) and Don Reimer (SPS).

GY Models in Use or Under Development for Operational Use in BC

	TASS	VDYP	WinTIPSY	STIM	Prognosis	MGM	SPS	Y-XENO
Variable Density	✓	✓	✓	✓	✓		✓	✓
						tree list	tree list	
Single Tree	✓		✓	✓	✓	✓	see note[38]	✓
Whole Stand		✓		✓				
Deterministic	✓	✓	✓	✓	✓	✓	✓	
Stochastic						✓		✓
User/Model Interface?								
Does the model run on a main frame, workstation or PC?	workstation & PC	DOS/PC VAX, UNIX	PC	PC	PC	PC	PC	Dos/PC
Is the model relatively user friendly?		✓	✓	✓	✓	✓	✓	✓
Applications								
Which applications was the model primarily designed for?								
Inventory		✓		✓	✓	✓	✓	
Forest Management	✓		✓	✓	✓			✓
Stand Management	✓		✓	✓	✓	✓	✓	✓
Is the model currently used for:								
Inventory		✓	--	✓	✓	--	✓	
Forest Management Planning	✓	✓	✓	✓	✓	--	✓	✓
Stand Management	✓		✓	✓	✓	--	✓	✓
Silviculture Treatment Planning	✓		✓	✓	✓	--	✓	✓
Timber Supply Projections	✓	✓	✓	✓	✓	--	✓	✓
Fire and Pests	✓				✓	--	decay	
Silviculture Treatments Modelled:								
Regeneration methods	--	NA	✓		✓	✓	✓	
Site preparation	--	NA			✓			
Spacing	✓	NA		✓	✓		✓	✓
Thinning	✓	NA		✓	✓	✓	✓	✓
Commercial thinning	✓	NA		✓	✓		✓	✓
Pruning	✓	NA			✓			
Fertilization	✓	NA			✓	✓	✓	✓
Herbicide Application		NA				✓		
Silvicultural System:								
Partial cutting	✓(patches)				✓		✓	

38 Stand table derived from tree list or forest inventory database information. Latest version displays spatial distribution of trees and crowns.

GY Models in Use or Under Development for Operational Use in BC

	TASS	VDYP	WinTIPSY	STIM	Prognosis	MGM	SPS	Y-XENO
Species Modelled	Interior & Coastal Douglas-fir, Western Cedar, Sitka Spruce, Lodgepole Pine, White Spruce	All commercial species	All commercial species	Coastal Western Hemlock, Aspen	Interior Douglas-fir	Aspen-Spruce	All species in BC, natural & managed	Coastal Douglas-fir, Western Hemlock
Stand Type:								
Pure - Even-aged	✓		✓	✓(Western Coastal Hemlock)	✓		✓	✓
Mixed species - Even Aged	✓(prorated)	✓(prorated)	✓(prorated)		✓	✓	✓	✓
Pure - Uneven aged					✓	✓	✓	
Mixed Species - Uneven aged					✓	✓	✓	
Mixed Wood						✓	✓	
Deciduous				✓(Aspen - incomplete)			✓	
Does the model result in information which can be used for non-timber values, such as:	(part of Sylver system)					additional analysis needed		E-Xeno
Wildlife habitat					✓			
Economic Values	✓		✓	✓	✓		✓	✓
Non-timber vegetation								
Does the model have an economic analysis module?	✓	✓					✓	
Is the model useable at the:								
Tree level	✓		✓	✓	✓	✓	possibly	✓
Stand level	✓	✓	✓	✓	✓	✓	✓	✓
Landscape or estate level		✓	✓	✓		✓	✓	✓
Is the representation of the forest canopy adequate for today's needs?	Single species-yes		Single species-yes		✓	?	?	
Is the model designed to run off existing inventory data?		✓					✓	

5. User Needs Assessment

5.1. Introduction

The assessment of user needs was grounded in a series of some 50 telephone and personal interviews with users throughout the province, combined with group meetings of ministry staff, industry representatives and consulting foresters at three locations – Nanaimo, Williams Lake and Prince George. A fourth meeting planned for Kamloops was unavoidably cancelled due to the unavailability of several of the key participants who had planned to attend. Some of the participants were subsequently interviewed individually by telephone.

Questions were formulated for discussion and comment in each of the program "topic" and "issue" areas listed in Table 3. Topic and issue areas were identified through a preliminary literature review and interviews with 10 GY experts.

The extent of the participants' contributions depended largely upon their experience and current role. Not all of the participants felt able to comment on all of the issues and instead some provided in-depth contributions on a limited number. Where issues remained left unaddressed, we sought additional information from people whose experience allowed them to address them with some authority.

We found that many of the comments and criticisms raised by the participants were being addressed in the Ministry, often by teams working closely with the GYPSC. However, the complex nature of GY model organisation and its implementation throughout the six regional and 42 district offices has resulted in communications problems between the "front line users" and those (usually at head office) responsible for designing and implementing improvements. Some users are finding it difficult to respond to increasing demands from their clients when they have a limited view of the directions being taken at head office. We should note that the reorganization of the GY program two years ago under the GYPSC, while not fault free, was seen as a significant improvement over the previous organisational regime.

While our discussions always focussed on GY models, it was often difficult to distinguish responses between those relating specifically to modelling and those related to the broader aspects of the GY program in general. For example, while users were very clear about where their difficulties lay in terms of modelling applicability in their own circumstances, they were often unable to cite where the problems originated. Frequently, they appeared to originate with the broader mandate of the program, and we have described them as such.

Unfortunately, despite considerable efforts on our part, and on the part of GY Steering Committee members, we were unable to convene meetings with the staff at FRBC responsible for the GY program funding strategy and direction during the course of our study. Accordingly, any comments in the table related to FRBC arise from the observations of other participants, not from FRBC itself.

Table 3

GY Modelling Topics and Issues for User Needs Assessment

1. **Organisation, Administration and Liaison**
   - Organisational issues which significantly affect the use of GY modelling in BC.
   - Shifting responsibilities for GY modelling in the future
2. **Resources to support GY program (funding, staffing, skills)**
   - Funding, skill, or other resource constraints in the GY area.
3. **Model applications**
   - Applications for which GY modelling is currently used or being developed.
   - Models performance and models currently being misapplied.
   - Major GY modelling gaps.
   - Do we need compatibility between models? Under what conditions?
   - Is there room for developing more than one model for the same application?
   - What are the problems related to the acceptance by government of model outputs used for forest management or regulatory purposes?
   - GY model applications most needed in the future. (say five years from now)
4. **Model inputs & data requirements**
   - Is the proper data being collected to support model development and "certification"?
   - New model development and approval ("acceptance testing"), including data issues.
   - Is the proper data being collected to monitor model performance against reality?
   - Is the proper data being collected to drive models?
5. **Model Development, Procurement and Operationalization**
   - Are efforts to procure, develop and operationalize existing models adequate?
6. **User/model interface**
   - Accessibility of models to the average user?
7. **Training**
   - Accessibility of training and advice to the people who need to use the models.
8. **Extension**
   - Are extension activities by the ministry and other organizations adequate?
   - Impact of extension efforts on GY modelling.
   - Who do you look to for advice and assistance in using GY models? How responsive have these organizations been?
9. **Model standards and guidelines – development, applications, maintenance, monitoring**
   - Adequacy of approval procedures.
   - Adequacy of validation and "certification" procedures prior to the application of models to ensure their appropriate use in particular circumstances.
   - Is the level of documentation sufficient to allow potential users to evaluate models' applicability to their own circumstances?
   - Are efforts to maintain existing models sufficient, and adequate to maintain a "certification" of the applicability for use?
   - Are there models in use today whose "certification" or relevance to today's conditions could be suspect? Is there an adequate feedback system to monitor the results of the model with the actual results in the field?

The user comments and contributions were wide ranging and complex and the results do not lend themselves to detailed analysis in narrative form. Instead we have presented the results, and our analysis, in tabular form (Table 4) with columns indicating:

- The topic and issue;
- Impacts and results;
- Initiatives under way to address the issue;
- Additional actions required.

The last column was used as the basis to formulate the recommended strategies in Chapter 6. However, it is emphasized that while the strategic direction was based largely upon the specific findings of the user survey, we have not attempted to address the "additional actions required" in detail. These will be addressed in due course in the overall context of the strategy framework.

The meeting in Prince George focussed partly on the user-perceived strengths and weaknesses of the two most commonly used models (VDYP and TASS/WinTIPSY) and a comparison with the newly developed Prognosis. The results of this discussion are summarized in Table 5.

Table 4

GY MODELLING - NEEDS ASSESSMENT

Observation/Issue	Impact/Result	Initiatives Underway To Address Issue	Additional Actions Required
1. Organisation, Administration, Liaison			
• Lack of "ownership" of GY Program.	• "Us versus them" attitude (industry). • Initiatives often falter/progress slowly. • Low level of accountability.	• Renewed FPC, GY Steering Committee, SIGY Co-op. • Increasing use of inter-agency working groups with lines of accountability formalized (i.e., Prognosis Working Group).	• Continued and expanded use of working groups. • Additional measures required to bring industry into provincial GY Program.
• GY Program is not formalized.	• Limited understanding of GY program in districts and regions. • Lines of accountability appear "blurred". • Commitment to program more difficult to maintain.	• GY Program Strategy to be released by GYPSC. • FPC	• Program designed according accepted program design principles. • Communication strategy for GY program.
• Lack of measurable success indicators for GY Program (performance monitoring).	• Monitoring of program inhibited. • Capacity to "steer" GY program adversely affected. • Ability to make strategic choices limited.	• None	• Program designed according accepted program design principles which would include the identification of measurable success indicators.
• Low level of co-operation and coordination in GY initiatives.	• GY resources do not seem to be "strategically directed" (from a province-wide perspective). • GY resources may not be optimally allocated.	• Renewed FPC mandate. • SIGY Co-op initiated. • GY Steering Committee meets regularly to coordinate MOF activities. • Working groups comprised of most stakeholder groups.	• Maintain commitment to co-operative approaches to meeting GY objectives. • Enhance linkages between agencies. • Ensure initiatives are guided by formal, accessible plans. • Working Groups supporting FPC and GY Steering Committee are assigned specific terms of reference, have membership from key stakeholder groups and are guided by formal plans (Prognosis BC initiative may be instructive).
• Victoria priorities sometimes at odds with regional user needs. • Some clients note that Victoria. has poor understanding of regional needs. • Regions/districts not always well informed of GY initiatives and GY program content.	• Regional/Victoria tension. • GY initiatives do not appear responsive to user needs.	• Needs assessments conducted formally and informally. • Regional representation on new FPC. • GYPSC recognizes need to coordinate with regions.	• Regular needs assessments and "checkbacks". • Inclusion of regional voice in GY initiatives, TAC and working groups. • Inform regions and districts of GY initiatives underway through extension program. • GY communication strategy and GY modelling communication strategy.

Table 4

GY MODELLING - NEEDS ASSESSMENT

Observation/Issue	Impact/Result	Initiatives Underway To Address Issue	Additional Actions Required
• Volume-based tenures discourage industry involvement in GY.	• Industry participation in FPC and GY program may be adversely affected.	• New pilot projects (e.g., Lignum) • FRBC funding levels playing field somewhat.	• Identify incentives to secure long-term commitment of industry to GY, GY modelling and data sharing.
• FPC dominated by MOF.	• GY initiatives appear biased to MOF. • Low level of industry commitment .	• FPC recently reorganized to address issue.	• Periodic review of the state of the inter-agency GY organisation to ensure FPC is not "captured" by any single agency.
2. Resources to Support GY Program (funding, staffing, skills)			
• Insufficient staffing levels in Region and District for GY.	• GY initiatives proceed slowly/stall. • GY managed "reactively".	• None	• Re-assessment of staffing requirements to implement GY program. • Establish regional Co-ops which take on some regional responsibilities currently held by Operations Division.
• GY program not base funded - too dependent on outside sources of funding.	• No long term funding commitments. • Effective planning horizon constrained.	• Some program areas funded through single multi-year umbrella project (e.g., site productivity).	• FPC and MOF must seek out long term funding for "base" activities. • GY modelling should be funded through umbrella "program" (Site Productivity program serves as a model)
• Some GY proposals funded through FRBC are not coordinated with GY program.	• Scarce resources may not be optimally allocated.	• There are increased efforts to "network" with organizations and people involved in GY.	• Improve efforts to link-up with organizations and people pursuing GY activities outside of GY.
• FRBC funding process sometimes appears to be in conflict with GY Program goals.	• Some GY initiatives of strategic importance may not be funded or funded inadequately. • GY proposals may be tailored to meet FRBC priorities and funding criteria rather than those of the GY program.	• None	• Gain FRBC commitment to fund GY projects of strategic importance first. • Provide FRBC with detailed GY and GY modelling strategy. • Ensure that GY proposals are first endorsed by FPC.
• Inadequate level of funding for some GY program components.	• Some GY initiatives of strategic importance may not be funded or funded inadequately.	• None	• Fund areas of strategic importance first. • Commit more funding to GY program over time (say five years).

Table 4

GY MODELLING - NEEDS ASSESSMENT

Observation/Issue	Impact/Result	Initiatives Underway To Address Issue	Additional Actions Required
• Very few GY experts in industry.	• Potential for action too limited.	• None	• GY more actively promoted as a career opportunity. "Opportunities in GY" brochure perhaps. • Extend networks with other jurisdictions pursuing GY modelling initiatives. • Explore incentives to promote and maintain industry commitment to GY.
• Small pool of GY consultants to draw on.	• Potential for action too limited.	• None	• Fund areas of strategic importance first. • See training/extension (sections 7 & 8).
• Lack of GY expertise in recruiting pool.	• GY program expansion is limited.	• None	• Fund areas of strategic importance first. • See training/extension (sections 7 & 8).
• Skills currently spread too thinly over too many initiatives.	• Initiatives may be slow to progress • Projects managed off the "corner of the desk".	• GY Strategy and GY modelling strategy will provide some basis for allocating resources effectively.	• MOF and others involved in GY increase commitment to co-operative approaches. • GY initiatives of strategic importance undertaken first. • Develop partnerships with private sector.
• Staff burnout/overload.	• Initiatives may stall.	• None	• Reduce commitment of staff resources/reduce no. of projects managed "off the corner of the desk".
• GY overly dependent on specialist knowledge of particular individuals.	• Initiatives affected by availability of specialist. • Initiatives threatened by attrition.	• None	• Ensure initiatives can be conveyed through the life of the organisation. • Higher level of documentation and extension for GY initiatives required.
3 Model Applications			
Gaps in GY:			
• Forest Health Impact on yield;	• Root rot is significant in SI but cannot be modelled currently.	• SWAT • ROTSIM Data collection ongoing • Plan to refine Root rot calibration extension to Prognosis. • Plan to calibrate spruce budworm extension to Prognosis.	• Need to priorise modelling needs with respect to forest health.

Table 4

GY MODELLING - NEEDS ASSESSMENT

Observation/Issue	Impact/Result	Initiatives Underway To Address Issue	Additional Actions Required
• Operational Adjustment Factors for Environmental constraints;	• GY modelling not fully accounting for environmental values and objectives.	•	•
• Even-aged single species stands;	• GY modelling cannot model all major species.	•	• Identify priority species and importance relative to other gaps in GY models.
• Uneven-aged Stand models;	• Province putting greater emphasis on uneven-aged stand management.	• Prognosis • TASS	• Applicability of Prognosis to other parts of province needs to be explored. • Review funding priorities with respect to TASS and Prognosis.
• Mixed-wood stand models;	• There are no operational models for mixed-wood stands. • VDYP cannot model mixed-wood stands.	• MGM model development. • Inventory Prediction System (IPS) project will investigate MGM for inventory purposes.	• Develop long-term strategy to address needs related to mixed wood. • Increase BC's resource commitment to MGM.
• Deciduous stands;	• No operational GY models for deciduous stands.	• Some effort devoted to developing WinSTIM for this purpose. Initiative halted when CFS program funding was cut. • Research Branch undertaking some work .	• Examine development work on WinSTIM for deciduous wood modelling.
• Mixed species stand models;	• Presently TASS does not adequately model mixed species stands.	• 5 year GY research project examining complex, mixed species stands in ICH and Idf zones. • Southern Interior variant of Prognosis to be released in Oct. 1997. • 5 year funding commitment to undertake mixed species studies in Research Branch.	• Obtain assurred multi-year funding and partner with industry to develop Prognosis variants. • Linkages between silviculture and inventory data required
• Non-timber resources - esp. habitat modelling;	• Linkage between model outputs, stand attributes and non-timber resources poorly developed.	• Limited work done by Research Branch. • Most work being done in private sectors (e.g., ESSA , D.R. Systems).	• Required stand attributes for non-timber resource modelling need to be identified. • GY models need to be linked to site series.

Table 4

GY MODELLING - NEEDS ASSESSMENT

Observation/Issue	Impact/Result	Initiatives Underway To Address Issue	Additional Actions Required
• Models for Silvicultural Treatments including: – Thinning – Pruning – Fertilization – Spacing;	• Silviculture planners unable to model many of the treatment scenarios they may consider for particular stands. • Some models used to model treatments for which they were not designed for. • Models too limited in scenario options for particular treatments (e.g., WinTIPSY spacing age is too limiting). • Most incremental silv. treatments not modelled in Timber Supply Analysis.	• Prognosis • TASS • MGM	• Examine utility of WinSTIM and SPS for Silviculture planning. • In the long term GY tools in the silviculture planners tool kit should produce results which are reflected in GY models used in support of timber supply analysis.
• Models for Partial Cutting Systems;	• Use of partial cutting systems is increasing dramatically in BC. Impacts are unclear.	• Funding secured for Prognosis SI (Southern Interior) Variant: Five Year Strategic Plan. Prognosis will be released in fall 1997.	• Assess "need" for modelling partial cutting systems outside SI. • Develop long term strategy to address needs.
• Value and Quality Models;	• Clients generally unfamiliar with value and quality models. • There is a need to identify log values in TIPSY Economist.	• None	• More effort is needed to make clients aware of tools. • Future versions of TIPSY Economist should provide log value outputs - especially for coastal applications.
• Linking stand and forest level planning; and	• Stand level plans are being developed without a clear understanding of the forest level implications. • Extent to which forest level objectives are being met through stand level planning is not well understood.	• None	• Establish WG to identify required linkages between stand and forest level modelling to support stand level planning in context of forest level objectives. • Develop strategy to meet these needs.
• Decay and Waste.	• Growth and yield models do not predict or account for decay and waste.	• VDYP accounts for decay and waste. • Individual tree volume and decay prediction project undertaken by MOF is ongoing (1996 to 1999).	• GY Modelling Task Force to resolve data and application needs.
4. Model Inputs & Data Requirements			
• Existing data is not always accessible.	• Existing data not optimally employed.	• Some data sharing arrangements between public & private sector. • Some efforts to integrate existing data bases.	• Greater effort devoted to integrating existing data bases (e.g. ISIS and Inventory, research and inventory). • Review and address impact of intellectual

Table 4

GY MODELLING - NEEDS ASSESSMENT

Observation/Issue	Impact/Result	Initiatives Underway To Address Issue	Additional Actions Required
		• Some efforts to digitize hard copy data.	property rights protection on data accessibility.
• No link between inventory and site series.	• Habitat modelling impeded.	• Vegetation Resource Inventory (VRI) • Terrestrial Ecosystem Mapping (TEM) • OASIS • Silviculture Inventory Technical Committee is examining linkages required between FPB and RIB.	• No further action required.
• No link between inventory and silviculture data base.	• Development of common GY modelling architecture impeded. • Use of some models (e.g., Prognosis, MGM) will be limited for inventory purposes.	• None	• Link inventory and silviculture data base.
• Very little data for uneven-aged stands.	• lack of data prevents calibration of Prognosis for most of the province.	• UBC undertaking research on uneven-aged stands in Cariboo Region. • Research Branch has secured funding for 5-year project focusing on uneven -aged stands.	• PSP strategy must be developed by FPC. • Commitment to enhancing data and identifying appropriate surrogates in short term. • Develop procedures to guide establishment of PSPs.
• Very little data for partial cutting systems.	• Lack of data means Prognosis will not be calibrated for most areas of the province.	• Some trials underway.	• PSP strategy must be developed by FPC. • Identify appropriate surrogates in short term to address data gaps. • Develop procedures to guide establishment of PSPs.
• Monitoring Plots.	• Degree of error for most models not known.	• Monitoring Task Force is identifying the role of monitoring plots.	• Initiative underway - additional action not required at this time.
• Volume and Decay data needed.	• Timber Supply is thought to be conservatively estimated.	• MOF undertaking volume and decay monitoring in ICH wk1 and vk 1 zones.	• Other biogeoclimatic zones need to be priorised.

Table 4

GY MODELLING - NEEDS ASSESSMENT

Observation/Issue	Impact/Result	Initiatives Underway To Address Issue	Additional Actions Required
• Basic data for forest health is lacking (e.g., root rot). • Inventory data for young and old stands is unreliable.	• Development of extension to GY model precluded. • Inaccurate AACs. • Misappropriation of silviculture money. • Ecosystem mgt. adversely affected.	• Some work on root rot in Southern Interior. • Integrated Resource Inventory Program (RIC).	• Data needs for modelling forest health need to be identified and priorised. • Adaptive Management Strategy for RIC.
• Inventory predictions too dependent on photo interpretation. • More accurate estimates of site productivity required.	• Inventory estimates at finer resolutions such as the landscape unit level are unreliable. • Site productivity is considered to be underestimated in many cases which means that model outputs are considered overly conservative.	• IPS. • Ground Based version of VDYP available (to be replaced by IPS). • OGSI • OASIS • SIBEC - field guide for determining site index for species on specific ecosystems.	• Basal area data needed - priorities areas need to be identified. • Assess feasibility of alternative methodologies for assessing site productivity. • Identify priority species. • Developing more precise measures of site productivity remains a priority in GY program. • Update 5-year plan.
5. Model Development, Procurement and Operationalization			
• Model development, procurement and operationalization process has generally been too slow.	• GY modelling needs are not met in a timely fashion.	• Prognosis initiative is gaining momentum. • GY Modelling Strategy	• Develop MGM implementation plan. • Undertake Technical review of models (including estate level) with potential application in BC. • Define role of SPS in GY modelling.
• Licensing arrangements and impact of copyright laws on GY efforts not clear.	• Future role of some GY models in BC questioned. • Accessibility of GY tools may be affected.	• None	• Review current licensing agreements. • Identify and resolve copyright issues that may impact GY modelling program.
• Perception that MOF has discouraged development of some GY models. • Focus on empirical yield functions for inventory.	• BC has been slow to address many of the major gaps in modelling. • BC's modelling program historically focussed on research to the detriment of operations.	• MOF now focusing on adequacy of model outputs rather than models. • Funding support for Prognosis has increased.	• Review funding with respect to development of models in priority areas. • See comments in Section 9 - Standards and Guidelines.
• Efforts to operationalize Prognosis have been inadequate.	• BC does not yet have an operational model for complex stands.	• Prognosis is expected to be operational for the Southern Interior by late 1997. • MGM • IPS	• Assess feasibility of operationalizing Prognosis for other regions following implementation of SI variant.

Table 4

GY MODELLING - NEEDS ASSESSMENT

Observation/Issue	Impact/Result	Initiatives Underway To Address Issue	Additional Actions Required
6. User/Model Interface/User Support			
• Models which are certified for use should be made available to Region, district and industry people.	• Flexibility of regional and district level model users is reduced.	• FPDS is planning to allow access to TASS through Internet.	• No additional action required.
• Variety of models that can be used are not presented in an accessible coherent package.	• Use of some models is limited by inconvenience of accessing them • Users have to jump from tool to tool.	• None	• Develop single common architecture that houses all GY models in their "tool kit".
• TASS, SPS and Prognosis are considered too complex for the average user who has limited education and experience in GY topics.	• Some models are not used due to their complexity. • Models are sometimes misapplied inadvertently.	• None	• Additional training. • Substitution of complex models with simpler models when possible (for silviculture planners). • development of simple user/model interfaces (Windows driven). • Models should have sufficient depth to allow user to understand assumptions and limitations that underly their GY modelling application. • Development of single common architecture for models in GY modelling tool kit.
7. Training			• 5-year training and extension plan required.
• SIBC does not provide enough training in GY.	• Opportunities to enhance skills of labour pool are restricted.	• None	• SIBC should offer more intensive course(s) devoted to GY (i.e., an expanded Module 3).
• District level staff do not receive enough GY training and cannot afford to send people to SIBC.	• District level does not receive enough training.	• Some computer-based training (CBT) initiatives underway. • Internet is being targeted more frequently as a way to reach clients.	• Fewer district level people should be trained but they should receive more intensive training. These people can then act as resource for district. • Need training delivered to district - perhaps more CBT.
• GY experts are a scarce resource.	• Scarce human resources not optimally allocated.	• RIB moving out of direct delivery of training. • RB being pressured to move out of direct delivery of training.	• MOF should reduce its involvement in the direct delivery of training and ensure that it is done well by other means.

Table 4

GY MODELLING - NEEDS ASSESSMENT

Observation/Issue	Impact/Result	Initiatives Underway To Address Issue	Additional Actions Required
• Silv. planners are in greatest need of training and are most diffuse client group.	• GY modelling efforts hampered by lack of skill/knowledge.	• None	• Increased level of effort required to identify this client group and their GY modelling and training needs.
• GY training is not geared towards particular roles and responsibilities of clients.	• Low level of client interest in GY - relevance of GY to their circumstances not convincingly demonstrated.	• None	• Training approaches must couch GY within broader interests of clients.
• Degree granting institutions do not provide enough background into GY.	• Small pool of labour who have GY background. • There is a lack of understanding of basic GY concepts and principles.	• SIBC provides basic training in GY.	• Raise profile of GY and GY modelling in educational institutions. • resume efforts to secure endowment for GY chair at UNBC and UBC. • Degree granting institutions need to provide more opportunities for GY education. • MOF implement a scholarship program for studies in GY. • Offer work-terms with MOF or others with GY programs.
8. Extension/User Support			• Develop 5-year training & extension plan.
• Users lack information on model parameters.	• Model users not sure when to use particular models.	• None	• Develop decision tree to assist client in identifying suitable models.
• More information about other models in use	• Users not sure if they are using most appropriate model • Users lack basic understanding of what is available.	• None	• Develop decision tree to assist client in identifying suitable models. • Backgrounders on models in use in BC.
• Users not sure how to interpret scenario in terms of model parameters.	• There is no consistency in approach to modelling scenarios among model users.	• None	• GY Modelling Workshop. • Prepare extension material which examines how real life scenarios have been interpreted in terms of model parameters.
• MOF agencies cannot support models adequately.	• Some models have not been supported (i.e., WinSTIM).	• Funding application for a GY modelling support centre submitted to FRBC. • Ministry considering having agency outside of MOF provide user support for Prognosis.	• User support Centre(s) - support services contracted out to consulting agency(agencies).

Table 4

GY MODELLING - NEEDS ASSESSMENT

Observation/Issue	Impact/Result	Initiatives Underway To Address Issue	Additional Actions Required
9. Model Standards and Guidelines - Development, Application, Maintenance., Monitoring			
• GY modelling occurs in an environment devoid of common, codified standards and guidelines.	• Approval processes appear subjective. • Model users lack common approach. • Model developers and users unaware of min. standards.	• Some efforts have been made to codify the process for approving yield curves. • Timber Supply Branch is developing formal guidelines and standards document (for approving yield curves).	• Additional codification required. • MOF aims for transparency in decision making through the development of clear standards and guidelines.
• Procedures for approving growth and yield curves are not formalized.	• Yield curves approvals appear overly subjective. • Process appears biased to MOF interests and models. • Model users see approval process as a "black box". • Model users not sure what documentation they must provide with data outputs.	• Model users becoming more familiar with the needs of MOF staff who approve yield curves.	• Principles and process for approving yield curves need to be formalized and presented in hard copy form to model users and developers. • Model certification required.
• There are no monitoring procedures.	• Degree of uncertainty associated with model outputs is not adequately known.	• Monitoring Task Force charged with investigating all aspects of monitoring for GY and will recommend standards and procedures to develop provincial GY system (timeline 1996 - 1999).	• No further action required at this time.
• Clients not sure which models they can use and which are most appropriate to particular circumstances.	• Misapplications. • Some models are not being used but could be.	• Prognosis use policy.	• Use policies for all GY models used in BC are needed (Prognosis use policy is a good start). • A decision tree to guide clients in choosing GY models for particular circumstances is required.

Table 5
Client Views - Model Strengths and Weaknesses[39]

	VDYP	TASS/WinTIPSY	Prognosis
Perceived Strengths	• Broad representation of forest types • Considered reliable for volume • Not suitable for silvicultural prescriptions • Will likely become a less important tool as time goes on.	• Data OK for the 7 individual species • "probably best in world" at what it does • great on pure stands	• Can model a wider range of conifer species • Does mixed stands • Becoming user friendly • Does uneven-aged stands • Proven robust in US for a wide variety of stands • Wide range of stand attributes (snags too)
Perceived Weaknesses	• Estimates of site index • PSP data not representative (too site specific) (may be skewed) (birch, aspen, etc.) • Poor representation of older age classes • Regional DWB factors • User doesn't know how representative they are (traditional species) • "Junkier stuff not represented well" • Doesn't represent changes in species (not dynamic)	• Does not represent many forest types. (only models 7 of the 20 major commercial species) • No mixed stands • No multi-cohort stands • No treatments (TIPSY) • No warning that says model is less accurate with extreme SI's (upper SI's capped to be conservative) • Ministry is not collecting PSP data in managed stands therefore no potential for ongoing validation • TASS does thinning - 7 species and even-aged - Only does these "controlled" situations. • Doesn't deal with competition between species.	• Only calibrated for extreme southern BC forest types • Not user friendly (but becoming more user friendly) • No regional representation • Difficult to understand how it is working • Site productivity not SI driven uses ecosystem instead of SI • Source of data for calibration?

39 Client views as reported at the Prince George meeting.

6. Strategic Directions for GY Modelling

This section outlines the vision for GY, broad principles that should guide GY modelling, strategic goals for GY and strategic directions to meet these goals and conform to the guiding principles.

6.1. Vision and Principles

The FPC is presently revising its vision of GY to better accommodate an ecosystem-based approach to GY. The following vision is suggested in this regard:

> *"To be able to consistently and accurately predict the dynamics of BC's forested ecosystems under any resource management scheme."*

In developing strategies to meet this vision, we have assumed the following principles:

- Parties with a key interest or stake in particular GY initiatives will be encouraged to participate in the development of suitable models, applications and data;
- Resources will be directed to GY initiatives of strategic importance first;
- "Corporate" directions in GY methods and approaches will be developed when feasible;
- GY clients will adhere to common principles, guidelines, processes and standards for GY activities they undertake;
- Collaborative, interdisciplinary approaches to solving problems will be encouraged;
- The GY program will strive to measure and maintain accountability for performance;
- The GY Program will be responsive to client needs;
- Long and short term objectives will be balanced; and
- Optimal use will be made of existing resources, GY tools and information.

Recommendations made in each of the strategic areas identified earlier in the study are designed to move BC closer to realizing the stated vision for GY and to ensure that GY is guided by the aforementioned principles. The strategic directions and recommendations are discussed below.

6.2. Organisation, Administration and Liaison

Proposed Strategic Goal: ***Ensure that the organisational framework for GY allows for the development of "corporate" approaches to GY and engenders long-term support for GY modelling activities in BC.***

GY modelling activity occurs within an exceptionally complex administrative and organisational framework. Low levels of cooperation between different agencies, the absence of a formal GY program structure, and the "lack of ownership" with respect to the GY program were some of the key issues raised in the course of our study. Some problems were in part attributed to these perceived issues including the "us versus them" attitude between industry and MOF agencies (and to a lesser extent between MOF agencies), the slow progress made on some GY initiatives, and the abandoning of others, for example.

Many of these conditions are changing quickly for the better, but considerable confusion exists among GY clients during this period of change. In some cases, the complexities surrounding particular issues and the lack of appropriate extension and communication activities has led to misunderstandings with regard to the organisational and administrative framework for GY.

The MOF and other organizations pursuing GY activities remain committed to steering and managing the GY program through interagency mechanisms which bring together relevant branches and organizations into a common body. To this end, the FPC has recently been re-established, a regional co-op appears to be taking root in the Southern Interior and the GY Steering Committee continues to improve the cohesion and coordination within the MOF's GY Program.

There are both positive and negative features of such an approach. Creative solutions often emerge, GY outputs hold greater legitimacy in the GY community, tensions are more easily resolved and client needs may be more easily communicated. But there are also risks. Initiatives may falter or progress according to the issues driving each of the constituent agencies and the GY organisation is more prone to losing cohesion and breaking down.

Our recommendations center on the need for controls which ensure that the GY functions are clearly identified and purposively steered to improve understanding of the framework for pursuing GY and build commitment to and support for the organisational framework. These controls will assist in maintaining a stable, purposeful and accountable organisational and administrative framework. Such a framework is an essential foundation for the GY modelling strategy.

Role of the FPC

We strongly support the newly reconstituted FPC, its renewed mandate and underlying concepts, in particular its consideration of forest ecosystem issues. There are three matters which we consider critical to its continuing positive influence – roles, budget and TAC structure.

In order to be effective, the FPC will need to accept the responsibility for developing recommendations to the Chief Forester based on independent research and advice which it is able to control directly. This should not be subject to conflicting resource priorities in the Ministry or any other agency. In turn, this will need a source of independent funding, controlled by the FPC as to its use.

The following are features we would like to see developed in the FPC over the coming months:

1. Acceptance of an independent and objective research role in GY development.
2. Sufficiently frequent meetings (at least quarterly) to ensure continuity of thought on key issues.
3. TAC's appointed on a project driven basis (as well as standing committees), of limited duration, and given specific terms of reference.
4. A published business plan, that draws upon the relevant strategies outlined in this report.
5. Adequate direct funding to enable the FPC and its TACs to undertake projects which it wishes to undertake independent of the Ministry.
6. Long term funding to ensure financial continuity of long term strategic research projects.

Accountability

The information presented in Chapter 3 indicates how complex the GY organisation is. We identified fourteen separate organisations which have responsibility for some part of the program. As a result, the accountability relationships are not always clear. That GY has made significant progress over the last several years is due more to the dedication of the individuals involved rather than any inherent qualities of the organisation. The accountability relationships and processes need to be clarified.

Recommendations:

1. Formalize the GY program and design and document it according to accepted program design principles. The program design model should include the following features:
   - Identify the players
   - Specify which stakeholders benefit, and how
   - Evaluate alternative means of program delivery
   - Consider compatibility and linkages with other programs, and any potential for overlap or redundancy
   - Maximize cost-effectiveness and efficiency of delivery method chosen
   - Ensure the program is consistent with accepted government management principles

- Ensure financial predictability and feasibility
- Allow for program flexibility if conditions change
- Examine for potentially unintended consequences
- Determine implementation feasibility and practicality
- Build in cessation provisions for specific activities, and
- Design and implement performance measurement and program evaluation systems which may include:
  - identification of success indicators
  - formative evaluations
  - needs assessments
  - maintaining ongoing monitoring capabilities

  The description presented in Chapters 2 and 3 may be used as the starting point for this activity.

2. Develop a new GY communication strategy (including a GY modelling communication strategy) to convey program and strategy details and current initiatives. This strategy serves a two-fold purpose by raising awareness and managing expectations related to GY modelling.
3. Continue to use working groups, co-ops and TACs which have the support of the provincial GY community to undertake well defined, problem oriented projects or tasks. As such these bodies must be:
   - assigned specific terms of reference which:
     - define the problems;
     - explicitly' link projects to problems;
     - identify project terms;
     - are limited as to duration; and
     - identify project deliverables.
   - comprised of members from each of the agencies with an interest in a particular initiative; and guided by formal project plans. (The Prognosis BC approach serves as a model for future working group activities.[40])
4. Operate the GY Program under a 10 to 15 year planning horizon to ensure that plans to meet short and long term goals can be properly developed and implemented and that an appropriate balance is maintained between them.
5. Develop a formal business plan for each one to three year "rolling" planning period.

6.3. Resources to Support the GY Program

Proposed Strategic Goal: ***Secure sufficient resources (including funding, skills and personnel) to pursue GY initiatives of strategic importance in a timely manner.***

There are only a small number of GY experts in the province. Many of these people work within the MOF, while the remainder can be found in industry, private consulting practices and academic institutions. GY experts are a precious resource currently stretched thinly over many initiatives. As a result, some organizations are seeing, increased staff burnout, slow progress on some initiatives, the occurrence of too many projects sometimes managed off of a single desk, and initiatives faltering when a project "champion" leaves or retires. The small pool of available qualified GY experts cannot be brought to bear adequately on all GY issues.

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[40] Ministry of Forests (n.d.). *Prognosis BC*.

In addition, the capacity to achieve long-term GY objectives is being compromised by the absence of a long-term funding commitment. As such, many of the long-term objectives of research and development work in GY and GY modelling are at risk. Further, given the risk posed to long-term objectives, there has been a tendency to focus efforts on short-term objectives and to develop "quick fixes."

Now that FRBC has become the greatest source of funding for GY initiatives, users feel that the capacity to develop a long-term GY modelling program has been further eroded. During the course of our work we have encountered several incidents where conflicts in funding criteria between FRBC and agencies such as the MOF have caused GY modelling initiatives of relatively great importance to the MOF to go unfunded while others of lesser importance did receive funding.

Given these condition, two key challenges face the GY community. Firstly issues of strategic importance must be addressed first. Many of the objectives identified with respect to organisational and administration issues are intended to promote the capacity to act strategically. As well, however, sufficient control over the allocation of funding and security of funding over an adequate planning horizon (say 10 to 15 years) is required to ensure that greater emphasis is placed on identifying and working towards long-term objectives.

Secondly, the pool of available GY expertise should be enhanced. Additional training and teaching could be provided (issues addressed in the "training" section below). In addition, the GY program must be more actively promoted as a "career opportunity." The pool of labour may also be boosted somewhat by extending networks to GY experts abroad. However, working in the BC GY community is less likely to be attractive when there is a perception that no long-term funding for projects and activities.

Other aspects which have affected GY resources include the perceived "black box" nature of GY and consequent perceptions that GY-related decisions are overly subjective and biased towards MOF interests (a condition described frequently in our study). Some organizations have reduced their effort in GY and in other cases. GY experts have left the pool of GY expertise altogether because of this. Recent developments and our recommendations with respect to organisational, administration and liaison-related issues are intended to make some progress in alleviating this problem. Recommendations with respect to standards and guidelines address this problem as well (see Section 6.10, below).

Recommendations:

1. FRBC should commit long-term funding to support the GY program in BC. One suggested funding arrangement is to establish an annuity with a term of ten to fifteen years (which is reviewed every 3 to 5 years). The annuity should ensure that current annual expenditure levels are maintained and, if possible, enhanced However, long-term continuity of funding may be as important as its actual level, since many GY projects are long-term in nature.
2. Partnerships between industry, MOF and academia should be promoted as a means to effectively implement and advance the province's GY program and GY modelling. In this regard, greater consideration should be given to incentives that promote industry participation in GY. (Without sufficient incentives, continuing commitment to the newly constituted FPC, and GY generally, cannot be ensured.)
3. Co-ops should be promoted as one of the key mechanisms to pool resources between industry, MOF and academia. (Co-ops may be funded through FRBC and industry contributions.)
4. Long-term funding should be used to attract people with required skill sets, alleviating some pressure to develop skill sets locally through academic institutions, industry and the Ministry.
5. Seek out staff with broader skill sets rather than narrow model-specific GY expertise. Acquisition of a generalized skill set enhances adaptability of staff and promotes a more efficient use of human resources.

6.4. Model Applications

Proposed Strategic Goal: ***Ensure that application related needs are identified and priorized.***

Clients identified stand types, silvicultural systems and treatments and other conditions which cannot be modelled adequately with the GY tools currently available. These included:

- Forest health impacts on GY (root rot in the Southern Interior was identified most frequently)
- Even-aged single species stands for some individual species
- Uneven-aged stands (a need identified in all regions)
- Mixed species stands (in all regions)
- Mixed-wood stands and deciduous stands (identified in the Northern Interior predominantly)
- Succession
- Deciduous stands
- Non-productive stands
- Young stands
- Silviculture treatments including pruning, thinning, spacing and fertilization
- Partial cutting
- Decay and waste
- Wood value and quality modelling
- Stand modelling which is linked to estate level models

As apparent from this list, there are perceived gaps in many areas. A vast GY program would be required to address the variety and number of gaps identified. However, given the current climate it is important that gaps of greatest strategic importance to each of the major client groups are addressed first. Care must be taken to avoid the risk of undertaking a modelling effort which is too broad in scope given anticipated resourcing constraints. There is some evidence that at present the GY modelling effort is too diffuse.

Our recommendations are centred on the lack of systematic and "objective" criteria to identify strategic gaps. Such criteria are essential to focus GY modelling efforts to produce meaningful results, in a timely fashion in areas of greatest need.

Recommendations:

1. Document required outputs for tree and stand simulators for each of the client groups.
2. Develop and implement formal criteria for priorizing modelling needs for each of the major client groups. As a starting point, a series of matrices should be developed which cross reference the major commercial species with stand type and management issue (forest health, silviculture treatments, setting AACs etc.). Key indicators for priorizing each intersecting point could include hectares covered, silviculture expenditures, time available and time required to address problem and expenditures. Areas of greatest strategic importance can then be identified along with an assessment of the current capacity to model them.

6.5. Model Inputs and Data Requirements

Proposed Strategic Goal: ***Ensure that model inputs and data requirements are being collected to use GY models.***

Modelling gaps are often indicative of data gaps. As such, model inputs and data issues are closely related to the theme of model applications.

Apart from this, there is increased focus on the landscape unit for inventory purposes and this has underscored the need for inventory data of a finer resolution than currently available. Similarly, silvicultural planners are becoming concerned that stand level planning is not adequately linked to forest

level objectives. In addition, the uncoordinated data collection and storage of GY data has been identified regularly as an impediment to an integrated, coordinated and responsive GY modelling program.

Recommendations:

1. Model requirements should be identified and documented prior to establishing data requirements.
2. An "end-state" for the database supporting GY modelling must be articulated in order to identify data gaps. These gaps are likely to vary in the short term as compared to the long term.
3. Formal criteria for priorizing data needs should be developed for each of the major client groups.
4. Promote the development of an integrated, coordinated, corporate approach to data collection and storage which maximises the use of existing data first.
5. Encourage the GY Co-ops as essential players in the continued development of the province's corporate data system.

6.6. Model Development, Procurement and Operationalization

Proposed Strategic Goal: ***To provide specific GY models that meet the needs of clients.***

There is currently no formal means of planning the aquisition of a model and approving its fitness for purpose. Nor is there a certification process which enables a user to know that the model he/she is using fits the data; does what he/she expects it to; has been subjected to a rigorous peer review process; and works according to a set of pre-determined standards. These are essential features which users have every right to expect.

Several initiatives are underway which will make some progress in satisfying the unmet client needs which were described to us. Work continues on Prognosis, TASS and MGM, for example. However, many clients believe that efforts to procure, develop and operationalize models have been inadequate and interview evidence suggests that efforts have not always been sufficiently well co-ordinated. Many have felt that the development of Prognosis BC has progressed too slowly while other models such as SPS have lost MOF support altogether (although still available for use in some districts) or shelved (WinSTIM). Efforts to identify other GY models which may meet particular user needs have been viewed as inadequate by some clients.

Recommendations:

1. Formalize the development/procurement process by including the following explicit functions:
   - Identify the business gaps (what we need versus what we have);
   - Articulate the business need;
   - Scan for existing models (BC and elsewhere) which will meet the business need;
   - Build only if there is no appropriate model to buy;
   - Address data issues re fit and validation;
   - Address data issues re model operation; and
   - Develop and articulate strategies for
     - procurement versus building models,
     - data, and
     - operationalization.
2. Conduct an ongoing scan of models used in BC and identify models which could be used in BC. Review should be undertaken by the FPC through an appointed TAC.
3. Models selected for use in BC should be approved and certified for use by the FPC.
4. Licensing/liability issues for GY models must be identified clarified and addressed as part of the model development, procurement and operationalizing process.

5. Criteria for investment in GY models should be established and should include costs, business plan, technical requirements, risk management issues and data availability.
6. Prognosis, MGM SPS, TASS, TIPSY, Y-Xeno etc. must be accommodated in an FPC approved strategy.

6.7. User/Model Interface

Proposed Strategic Goal: ***Develop and maintain a user/model interface that is menu-driven, user friendly and easy to understand.***

GY clients identified the need for a user-friendly interface. Clients noted that some models were very difficult to use and that a Windows environment or simplified front-end would improve accessibility. Others noted that, at times, they found themselves jumping from one model to the other and that a common interface for all models currently in use would be helpful. Finally, some found that the inaccessibility of TASS is adversely affecting their approach to modelling. Although, the support staff for TASS has been quick to respond to client requests for special runs, clients note that this relationship is cumbersome.

Recommendations:

1. A common architecture should be developed for GY models used currently. This architecture would be corporate in nature, housing inventory, silviculture and timber simply models.
2. Prior to developing this architecture there is a need to conceptualize a modelling system with a decision key that allows identification of model(s) appropriate to specific needs.
3. Simplify interface for specific models. When feasible, a Windows format should be developed with sufficient depth to allow users to understand implications of approaches.

6.8. Training

Proposed Strategic Goal: ***Improve the skills of GY clients to ensure that appropriate and optimal use is made of existing GY models.***

The need for more training in GY modelling was identified frequently by model users. We were told that this lack of training has contributed to misapplications in modelling, and an unnecessary limit on the diversity of GY tools employed.

Misapplications were identified with respect to inventory and silvicultural planning. In some cases models were run using scenarios inadvertently created and not representative of the actual conditions which were to be modelled. At other times models were being used for purposes for which they were not intended and for which they should not be used, without their limitations being properly taken into account.

Misapplications can have several effects:

- they increase the workload of those responsible for reviewing model outputs and slow administrative review processes;
- they have unrealistically increased the expectations of some clients;
- in the case of silviculture planners, misapplications increase the level of uncertainty surrounding modelling efforts and outputs; and
- inappropriate silviculture treatments may be prescribed.

Some also identified the need to provide training in models such as WinSTIM and SPS. In the case of the latter we were told by one interviewee that SPS, although once used in the District, had fallen into disuse because the person conversant with the model had left, despite considerable effort and expense made to calibrate it for the district. An obvious result is that models which may be available for use are not being used as widely as they could be.

GY training provided through degree granting institutions was also identified as inadequate.

Recommendations:

1. A concerted effort should be made in the shorter term to increase the level of user training for GY users in the field.
2. A training needs study should be implemented to identify the specific training requirements.
3. A "stand alone" GY training module for foresters should be developed to meet the needs, based on the current SIBC Module 3 curriculum, and offered independently of other SIBC courses.
4. The module should be delivered through SIBC, using private sector trainers where possible and/or the facilities of the Forests Continuing Studies Network.
5. MOF should reduce its direct involvement in the delivery of GY training courses[41]
6. In the longer term, the FPC should promote additional GY knowledge transfer through degree granting institutions. This might include:
   - Establishment of GY training as a mandatory component in a B.Sc. degree in forestry;
   - The attraction of graduates in quantitatively oriented degree courses such as computer science and engineering to work in the forest GY field; and
   - Providing strong support for financial resources needed to implement GY training where there is a need.

6.9. Extension & User Support

Proposed Strategic Goal: ***Improve GY clients' level of awareness of GY program and initiatives and provide user support at levels which ensure that optimal use is made of existing GY models.***

Model users identified that the quality of extension efforts and user support has improved significantly in the last few years. However, several outstanding concerns were identified. Model users need information about all of the tools available currently whether they are (or are expected) to be in use predominantly in industry or the MOF. For example, although SPS and Y-XENO tend to be used predominantly in industry and the consulting community, there is still a need to provide MOF personnel with background information on each of these models. In some cases this information is required because MOF personnel may be faced with the task of approving plans or outputs which were developed using these models.

Modellers also noted that they were not always sure when to use a particular model. They noted that more effort was needed to communicate model parameters to GY clients and to provide a decision key that allows them to identify models that are appropriate to their needs.

Users identified the need for demonstrations of real life scenarios interpreted for specific models. This was identified as an important extension activity that could aid in promoting a common core approach to modelling and interpreting real conditions in terms of particular models.

Finally, clients reported some confusion with respect to which models have been approved for use (especially with respect to silviculture). In part this perception is due to the lack of user support for some models (e.g., WinSTIM) and the consequent perception that these models were not endorsed by the MOF.

To date, extension and user support efforts have been focused on WinTIPSY and VDYP. Interview evidence suggests that these efforts have been well received by GY clients, but, a greater commitment to extension is needed.

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[41] During the course of the study, it was argued that in the ministry, GY experts' time was better spent in research and model development rather than in the delivery of training. This recommendation is therefore intended to ensure that GY experts are used as effectively as possible. It is also recognized that the ministry's GY experts have a much valued ministry context when teaching. As such, some training courses, whose success is dependent on effectively communicating this unique experience, must continue to be delivered by the MOF.

Recommendations:

1. A user support function should be established to provide assistance to GY users in the field The service should include quick advice on the GY models approved for use, including the advantages and disadvantages of the use of specific models in the circumstances identified by the user.
2. GY users in the field should be kept up to date on GY developments taking place in the MOF head office, or in other areas, which affect them directly or indirectly. The best way to do this would be through the MOF internet service.
3. MOF should investigate the option of contracting out the user support function to a private sector agency, which might also offer similar services to industry.
4. A multi-year training and extension plan should direct extension activities.
5. Greater efforts are required to make GY clients aware of GY initiatives and current research.

6.10. Modelling Standards and Guidelines for Development, Application, Maintenance and Monitoring

Proposed Strategic Goal: ***Ensure that accepted standards and guidelines for the development, application, maintenance and monitoring of GY models are developed and communicated to GY clients.***

GY activity is characterized by an absence of explicit and recognizable standards and guidelines. Yet there is considerable uncertainty regarding the role and practicality of developing such standards and guidelines. Some strongly oppose the development of guidelines arguing that further abuses and misapplications of GY modelling are likely. Additionally, many argued that GY modelling remains a very subjective exercise and that guidelines will not change this condition. In opposition, others argued that guidelines are essential to move beyond the "black box" view of GY modelling and to develop approaches that command the legitimacy of MOF and industry alike. We support the latter view because misapplications of the technology, while not immediately apparent, can have significant long term consequences.

Some of the areas and functions where standards and guidelines do not exist are as follows:

- The recertification of specific GY models to be used under particular circumstances such as location and areas, species, silviculture applications, age, etc.
- The process of approving and certifying models for particular usage;
- The process of maintaining the certification, or recertification, of models and applications;
- "Use policies" or "practice codes" governing the use of GY models;
- Performance monitoring processes used to ensure what models, and the data used in them, continue to be relevant; and
- The acceptance and approval of specific yield curves.

The GY process has survived and flourished in the absence of such standards and guidelines processes. However, its increasing importance to the forest managers of the 21st century will require that these critical processes be documented in a formal way.

Recommendations:

1. Establish certification processes for GY models and development of yield curves.
2. Develop standards and guidelines to address species, geographic limits, treatments, and resolution (age classes, individual stand densities etc.)
3. Develop "use policies" for current GY models to ensure that models are wisely/appropriately used (Prognosis "use policy" can serve as an instructive model).
4. Establish monitoring procedures to ensure that GY tools are periodically evaluated and "re-certified."

6.11. Conclusions

We have concluded that GY modelling in the province suffers form a lack of coordination and more importantly from a lack of protocol and trust. However, many initiatives are now underway to counter this, and our recommendations reaffirm many of the directions already taken. Some aim to fine-tune these directions, as in the case of extension. Other directions proposed and not yet taken by the Ministry are directed to improving the capacity to steer the course of GY modelling by improving the level of trust, cooperation, and adaptiveness in the GY community.

The following chapter provides a "first level" priority assessment of the recommendations outlined above. It is anticipated that these priorities will be confirmed and refined over the coming months through consultation with a wider audience.

7. Priorising and Scheduling the Strategic Directions

7.1. Methodology

This chapter presents a first-level assessment of priorities and scheduling for the strategies and recommendations identified in the previous chapter. Some 70 members of BC's GY community were invited to participate in a simple priority ranking exercise. Individual recommendations were ranked using the ranking sheets shown in Appendix 3.

The recommendations were ranked according to two key and three subordinate criteria on a 1 to 5 scale where 1 = very low and 5 = very high. The criteria were as follows:

Key Criteria:

1. Importance – how important is the proposed strategic area/action?
2. Current level of satisfaction – what is the current level of satisfaction with respect to the issue(s) addressed by the proposed strategic area/action?

Subordinate Criteria:

3. Expected level of effort – how much effort will be required to implement the strategic action or address the actions proposed under the strategic area?
4. Urgency – is the action urgently required? What level of urgency is associated with the proposed strategic area/action(s)?
5. Barriers to implementation – How great are the perceived barriers which could impede implementation?

The participants were also asked to suggest when elements of the strategy should be implemented and to indicate how much elapsed time should be budgeted for initiatives supporting each recommendation.

The rankings were made primarily on the basis of the key criteria only. The highest ranked recommendations were those which address conditions ranked "very high" in importance and "very low" in terms of the current level of satisfaction. The subordinate criteria were used only to distinguish between similar rankings and to provide additional information on, for example, the magnitude of the implementation tasks. These other criteria may be used to refine the strategy at a later date.

The information collected with regard to the key criteria was depicted on two-dimensional matrixes, examples of which appear in Appendix 4. Each of the recommendations comprising the strategy were then ranked to indicate the expected amount of program emphasis using a four point scale (A = maximum level of emphasis, B = high level of emphasis, C = medium level of emphasis, and D = a low level of emphasis).

The elements of the entire strategy were then priorised over a five year period according to responses received in the "possible start date" and "possible duration" columns of the response forms. The information was then was used to compile the proposed five-year strategy, shown in chart form on the next page.

GY Modelling Strategy

Proposed Priorities and Implementation Schedule

	Ranking	1997/98	1998/99	1999/00	2000/01	2001/02
ORGANIZATION, ADMINISTRATION, LIAISON						
1. Formalize GY Program	B					
2. GY Communication Strategy	B					
3. Define Role of Working Groups	C					
4. Extend Planning Horizon (10 - 15 years)	C					
5. Develop Formal Business Plan	D					
RESOURCES						
1. Secure Long-term Funding	A					
2. Promote/Develop Partnerships	B					
3. Promote Coops as Means to Pool Resources	C					
4. Attract Required Skill Sets	C					
5. Seek out Broader Skill Sets	D					
MODEL APPLICATIONS						
1. Document Required Outputs for GY Models	C					
2. Develop & Implement Criteria for Prioritizing Needs	C					
MODEL INPUTS AND DATA REQUIREMENTS						
1. Identify Model Requirements	C					
2. Identify "end-state" for Data Base	C					
3. Develop Criteria for Prioritizing Data Needs	B					
4. Corporate Approach to Data Collection & Storage	C					
MODEL DEVELOPMENT, PROCUREMENT AND OPERATIONALIZATION						
1. Formalize Development/Procurement Process	D					
2. Environmental Scan - For Models	D					
3. Certification Process and Role of FPC	D					
4. Address Licensing/Liability Issues	D					
5. Investment Criteria	D					
6. Ensure FPC Accomodates Major Models	B					
USER/MODEL INTERFACE						
1. Develop Common Architecture for GY Models	D					
2. Conceptualize Modelling System	D					
3. Simplify Interface for Specific Models	C					
TRAINING						
1. Increase Level of User Training in the Field	A					
2. Identify Training Needs	C					
3. Develop Stand Alone GY Training Module	C					
4. MOF Reduce Level of Direct Involvement in Training	D					
5. Promote Knowledge Transfer	A					
EXTENSION AND USER SUPPORT						
1. Establish User Support Function	B					
2. Keep Operations Informed on GY Developments	A					
3. Investigate Option of Contracting Out	D					
4. Develop Multi-year Training and Extension Plan	A					
STANDARDS AND GUIDELINES						
1. Certification for GY Models & Yield Curves	C					
2. Species, Geographic Limits, Treatments, Resolution	B					
3. Use Policies	B					
4. Monitoring	A					

Key	Ranking			D	C	B	A
	colour code						
	amount of program emphasis		none	low	med.	high	max.

8. Next Steps

Growth and Yield is at a threshold in BC. The GY community has been quick to take up many of the merging challenges already but cannot yet ensure strong program coordination, responsiveness and effectiveness in this climate of shifting responsibilities, interests, and needs. We believe the GY modelling Strategy presented represents a departure from, and an improvement in, the way things get done.

The strategy presented here represents one of the first of many steps in the implementation of change. The real effort is yet to come, but come it must if the GY program and related activities are to meet the rapidly emerging needs of the managers of the forest resource throughout the province.

For the immediate future, the following steps are recommended for implementation over the coming months:

1. General acceptance of the recommendations contained in Chapter 6 and the preliminary estimates of timing in Chapter 7 by the GY Steering Committee;
2. Summarization and presentation to the Chief Forester and the FPC, together with preliminary estimates of timing and resources;
3. General approval of the FPC and the Chief Forester;
4. Development of a detailed implementation plan, overseen by the FPC on behalf of the Chief Forester;
5. Establish a GY Modelling Group to assist in developing an implementation plan;
6. Publication and distribution of the implementation plan; and
7. Implementation of the plan over a five year period.

* * * * *

We appreciate the opportunity to conduct this work on behalf of the Ministry and look forward to providing further assistance during the implementation of the strategic recommendations.

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Victoria, BC
November 1997

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Appendix 3 – Priorising and Scheduling the Strategic Directions – Survey Form

GY Modelling Strategy

Table 1 - Developing Priorities for Strategic Areas

Recommendation:	Importance (1 to 5)	Current Level of Satisfaction (1 to 5)	Expected Level of Effort (1 to 5)	Urgency (1 to 5)	Barriers to Implementation (1 to 5)	Possible Start Date (Year)	Possible Duration (# of months)
	Enter into each cell a rank of 1 to 5 1 = Very Low, 2 = Low, 3 = Medium, 4 = High, 5 = Very High						
Model Inputs and Data Requirements							
1. Identify model requirements							
2. Identify "end-state" for data base							
3. Develop criteria for priorising data needs							
4. Corp. approach to data collection & storage							
Model Development, Procurement, Operationalization							
1. Formalize development/procurement process							
2. Environmental scan - for models							
3. Certification process and role of FPC							
4. Address licensing/liability issues							
5. Investment criteria							
6. Ensure FPC accounts for major models							
User/Model Interface							
1. Develop common architecture for GY models							
2. Conceptualize modelling system							
3. Simplify interface for specific models							

Key
1. **Importance** - how important is the proposed recommendation?
2. **Current level of satisfaction** - what is your current level of satisfaction with respect to the issue(s) addressed in the proposed recommendation?
3. **Expected level of effort** - how much effort will be required to implement the strategic actions proposed under the recommendation?
4. **Urgency** - is the action urgently required? What level of urgency is associated with the proposed recommendation?
5. **Barriers to implementation** - How great are the barriers which could impede implementation?

GY Modelling Strategy
Table 1 - Developing Priorities for Strategic Areas

Name: _____
Organization _____
Location: _____
Phone/Fax _____

Role:
- GY Model User ☐
- GY Model Developer ☐
- User of GY Results ☐
- Data Collection ☐
- Other: _____ ☐

Primary Use:
- Timber Supply ☐
- Inventory ☐
- Silviculture ☐
- Other: _____ ☐

Importance (1 to 5)	Current Level of Satisfaction (1 to 5)	Expected Level of Effort (1 to 5)	Urgency (1 to 5)	Barriers to Implementation (1 to 5)	Possible Start Date (Year)	Possible Duration (# of months)

Enter into each cell a rank of 1 to 5
1 = Very Low, 2 = Low, 3 = Medium, 4 = High, 5 = Very High

Recommendation:

Organization, Administration, Liaison
1. Formalize GY Program
2. GY communication strategy
3. Define role of working groups
4. Extend planning horizon (10 - 15 years)
5. Develop formal business plan

Resources
1. Secure long-term funding
2. Promote/develop partnerships
3. Promote coops as means to pool resources
4. Attract required skill sets
5. Seek out broader skill sets

Model Applications
1. Document required outputs for GY models
2. Develop & implement priorization criteria

Key
1. **Importance** - how important is the proposed recommendation?
2. **Current level of satisfaction** - what is your current level of satisfaction with respect to the issue(s) addressed in the proposed recommendation?
3. **Expected level of effort** - how much effort will be required to implement the strategic actions proposed under the recommendation?
4. **Urgency** - is the action urgently required? What level of urgency is associated with the proposed recommendation?
5. **Barriers to implementation** - How great are the barriers which could impede implementation?

GY Modelling Strategy

Table 1 - Developing Priorities for Strategic Areas

Importance (1 to 5)	Current Level of Satisfaction (1 to 5)	Expected Level of Effort (1 to 5)	Urgency (1 to 5)	Barriers to Implementation (1 to 5)	Possible Start Date (Year)	Possible Duration (# of months)

Enter into each cell a rank of 1 to 5
1 = Very Low, 2 = Low, 3 = Medium, 4 = High, 5 = Very High

Recommendation:

Training
1. Increase level of user training in the field
2. Identify training needs
3. Develop stand alone GY training module
4. Reduce MOF's direct involvement in training
5. Promote knowledge transfer

Extension & User Support
1. Establish user support function
2. Keep operations informed on GY developments
3. Investigate option of contracting out
4. develop multi-year training & extension plan

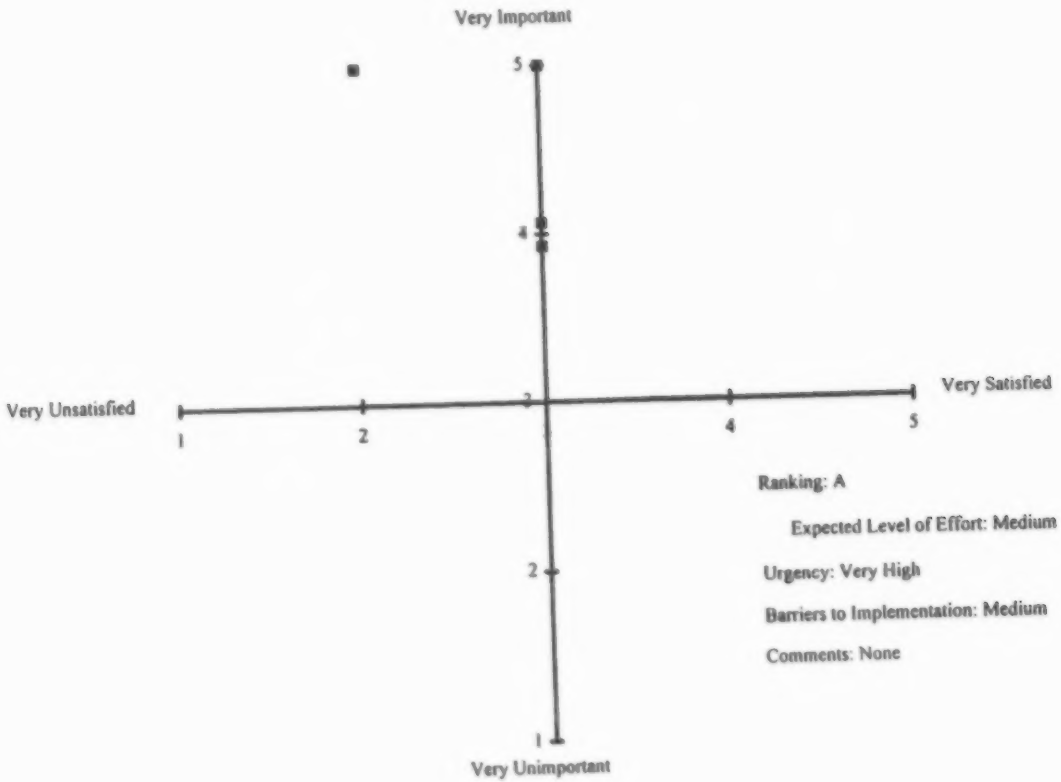
Standards & Guidelines
1. Certification for GY models & yield curves
2. Species, geographic limits, treatments, resolution
3. Use policies
4. Monitoring

Key
1. **Importance** - how important is the proposed recommendation?
2. **Current level of satisfaction** - what is your current level of satisfaction with respect to the issue(s) addressed in the proposed recommendation?
3. **Expected level of effort** - how much effort will be required to implement the strategic actions proposed under the recommendation?
4. **Urgency** - is the action urgently required? What level of urgency is associated with the proposed recommendation?
5. **Barriers to implementation** - How great are the barriers which could impede implementation?

Appendix 4 – Priorising and Scheduling the Strategic Directions – Selected Examples of Ranking Matrices

Chart5

Issue: Organization, Administration, Liaison
(GY Steering Committee)



Ranking: A

Expected Level of Effort: Medium

Urgency: Very High

Barriers to Implementation: Medium

Comments: None

Chart6

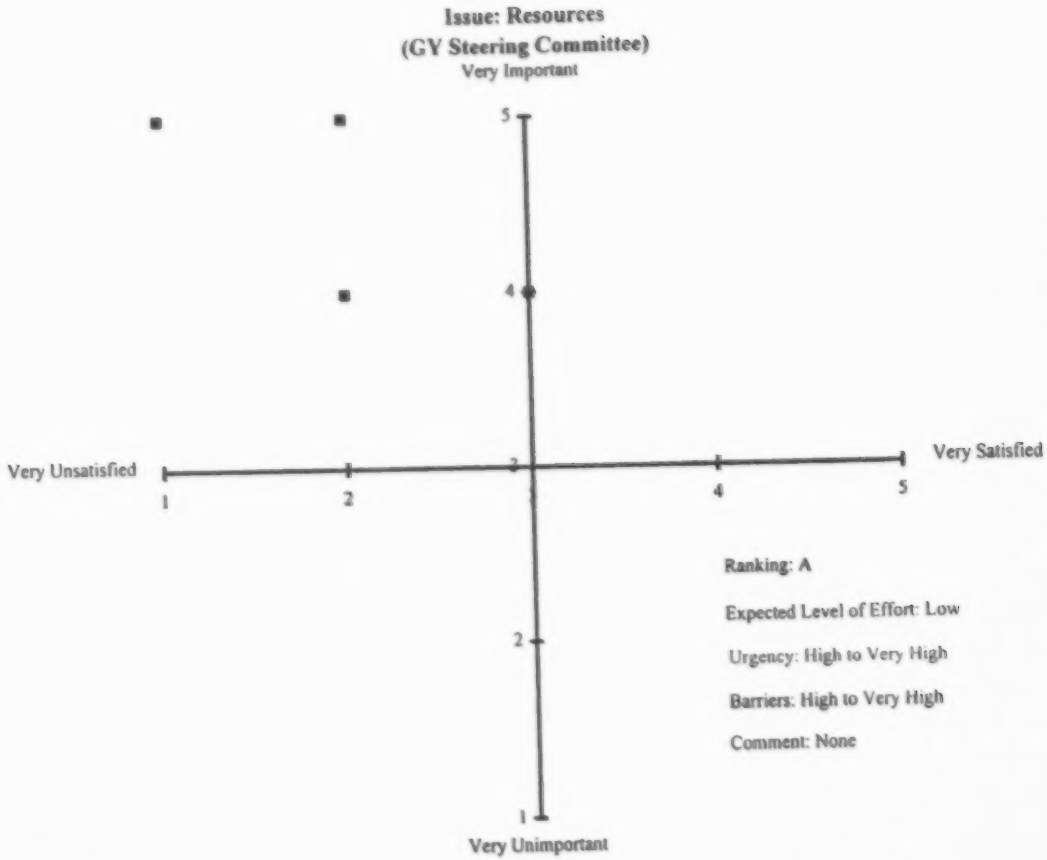

Issue: Resources
(GY Steering Committee)
Very Important
5
4
3
2
1
Very Unsatisfied
1
2
3
4
5
Very Satisfied
Very Unimportant
Ranking: A
Expected Level of Effort: Low
Urgency: High to Very High
Barriers: High to Very High
Comment: None

Chart11

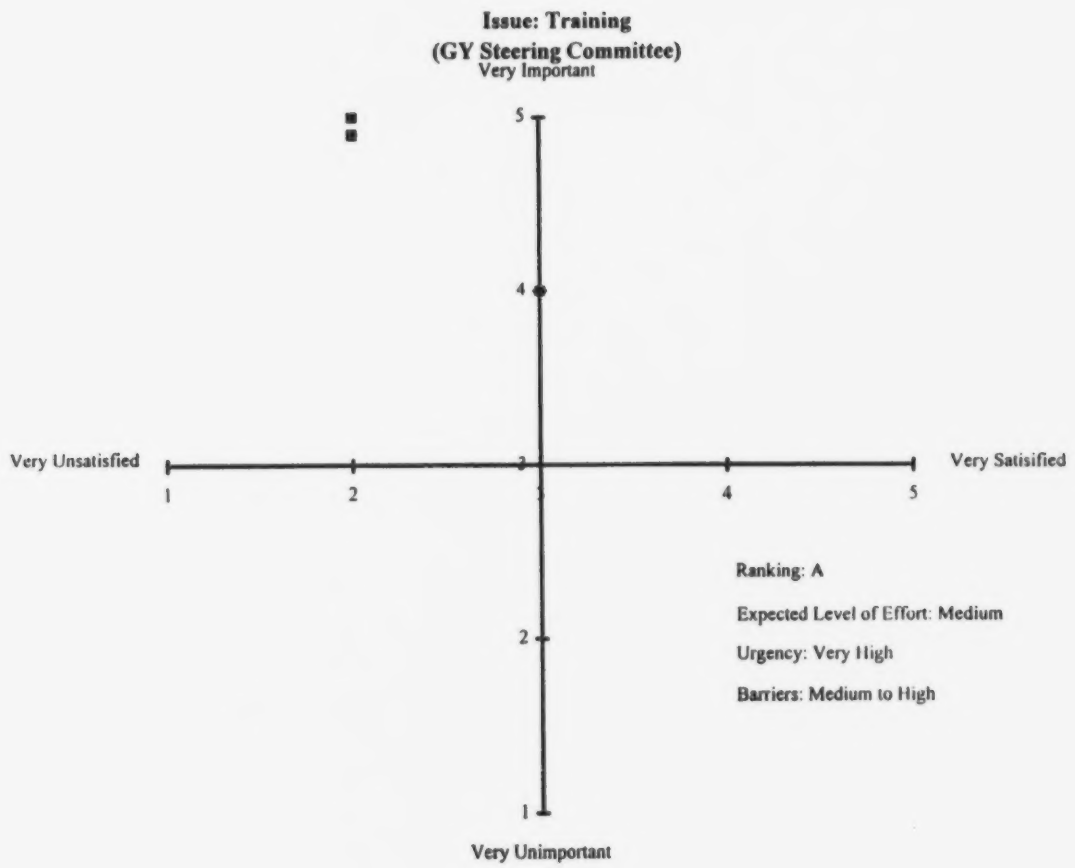

Issue: Training
(GY Steering Committee)
Very Important
5
4
3
2
1
Very Unsatisfied
1
2
3
4
5
Very Satisified
Very Unimportant
Ranking: A
Expected Level of Effort: Medium
Urgency: Very High
Barriers: Medium to High

Chart12

Issue: Extension & User Support
(GY Steering Committee)

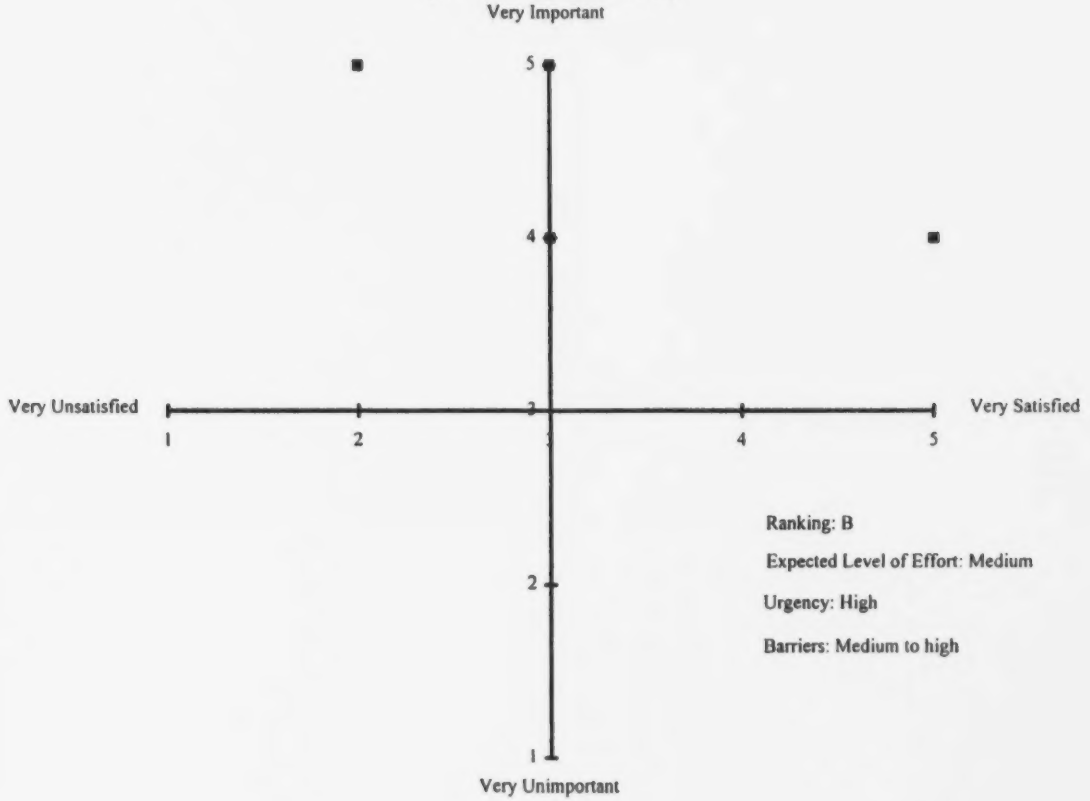
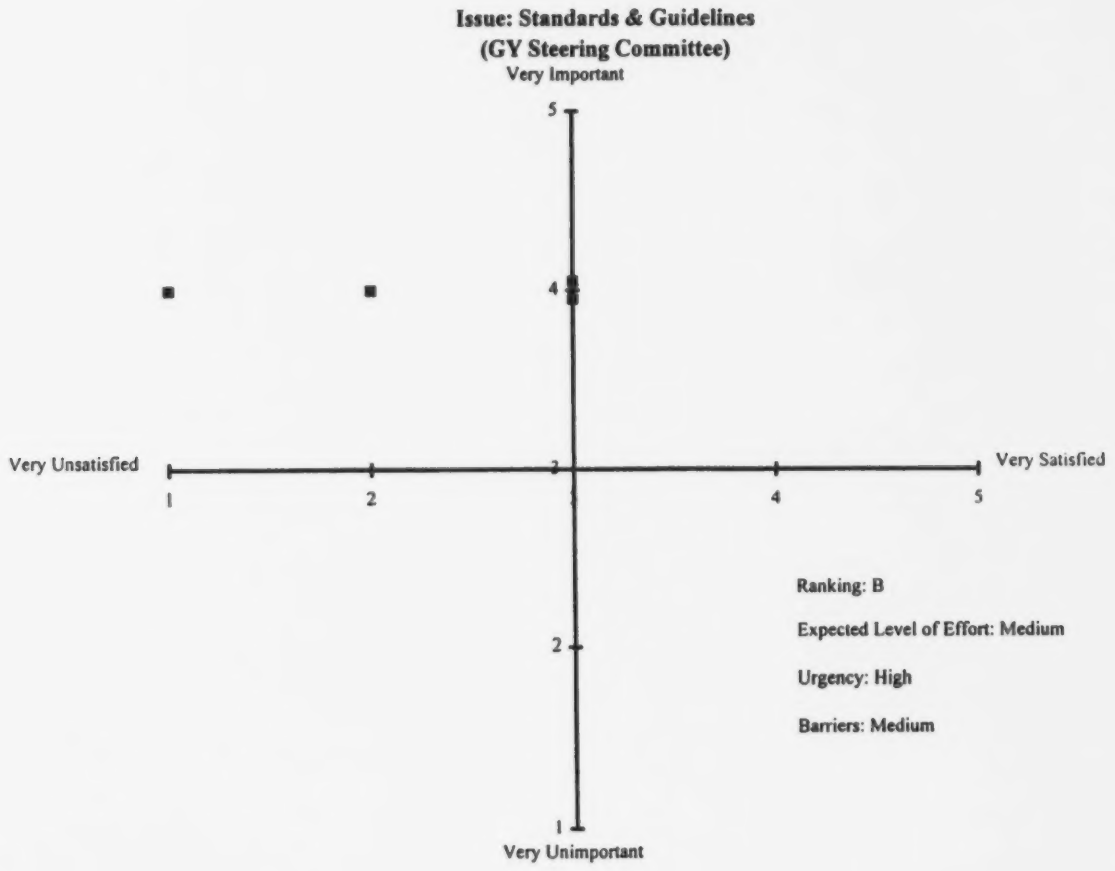


Chart13


Issue: Standards & Guidelines
(GY Steering Committee)
Very Important
5
4
3
2
1
Very Unsatisfied
1
2
3
4
5
Very Satisfied
Very Unimportant
Ranking: B
Expected Level of Effort: Medium
Urgency: High
Barriers: Medium

Appendix 5 – A Growth A Yield Modelling Strategy for British Columbia – Selected Review Comments (October 20 1997)

In August 1997, a draft of the proposed Growth and Yield Modelling Strategy for British Columbia was circulated to 70 people involved in GY modelling. Many of the comments received have been used to refine the strategy document.

Below, comments which underscore risks and bias inherent in the strategy have been culled from written comments received. These comments warrant careful consideration by the Forest Productivity Council and others as the GY Modelling Strategy is finalized and implemented.

Scope of the GY Modelling Strategy

- The implementation of such a grand vision will be fraught with difficulties. There is a need to pay greater attention to what is realizable.

Vision Statement for GY

- If we are guided by the proposed "vision-statement" we are doomed to fail: The vision statement about accuracy and precision on all ecosystems focusses attention on unattainable goals and too much detail and assumes unending funding. A better focus would be "to help us reach strategic decisions that affect the growth and composition of our forests that are both biologically based and financially sound."
- The newly formed FPC should have as its role a clear statement of "issues/problems" that need solving rather than the "models" to solve them.

Organization, Administration, Liaison

- Formalizing the GY Program. I am concerned that if taken over by the Government, GY initiatives have a very high risk of being bureaucratic and counter-productive. There is a danger that Government's vision will be imposed on all the players although they usually do not begin this way. The main reason for this is that funding, support, and approval of many program, proposals, and initiatives are only successful if they coincide with Government's ideas. The end result is that Government-lead strategic plans can discourage creativity and the ability of individuals to act.

GY Co-ops

- Co-ops are a very good idea, but they are extremely difficult to organize and run effectively. Sometimes it is better to have "loose" coops.
- There are virtually no coops for forestry R&D in Canada which have survived long, nor have many federal or provincial initiatives. There are many reasons why but these very reasons undermine the credibility of a "grand" strategy for R&D in GY in BC.

Funding

- We have paid a big price in lost efficiency in this province by trying to deal with long-term issues (like GY) under the umbrella of annual government budgets, and 4-5 year political lifetimes. The need for long-term funding is great.
- The report really needs to examine the constraints to GY R&D in BC and suggest ways to overcome them. A consultant report which ignores these realities will itself not be very relevant.

Partnerships

- Some partnerships are good, others are bad. All partnerships must be entered into carefully. Problems can arise in the partnership if the Government partner holds the political and funding stick.
- Interprovincial cooperation in GY is very logical but no mention of Alberta, Ontario and Quebec initiatives is made. It is bizarre each Province should each model the boreal forest.

Enhancing GY Modelling Skills

- We have lots of skilled people now in BC, but we do not have the infrastructure to allow them to be productive.
- Program managers should not seek out broader skill sets – they should have broader skill sets, and should have a bigger picture view of the business. They are the ones running the show, and they are responsible (at least they should be in the real world).

Model Development, Procurement, Operationalization

- Modelling framework: Encourage any model that helps solve the issues in a biologically sound manner, backed by data. Do not endorse a limited subset of particular models (endorsing a short list of models will stymie creativity).

Model Documentation

- There is lots of documentation now, no one reads it. Back to communication.

Developing a Common Interface for GY Models

- While a common interface is desirable to some users I doubt that is even feasible. Our current suite of models have such disparate tree, site and treatment parameters that a common front end would likely make things more confusing. A common front end would also serve to hide important differences between the models in terms of their capabilities, and might promote the practice of "model shopping," that is, of trying to figure our different models until you find the one that gives the answer you like while obscuring the reasons for the differences in the results.
- A common interface would potentially add complexity to the simpler models and water down the potential of more complex models.
- A common interface poses the danger of creating a "black box" approach to running models. It could be very dangerous to have people running models that don't understand what is going on inside.

Certification – GY Models and GY Model Users

- There seems to be talk of certifying models, does there also need to be a discussion of certifying users? The draft of the Density Management guidebook that was recently circulated for review seems to assume that everyone writing an SP or SMPO will have to support their prescription with model predictions in place of the former methodology of blindly following prescription standards. While I don't personally like prescriptive standards, I have already seen several proposed prescriptions "supported" by model output which in reality do a worse job of achieving stand level objectives than they would have following the old inflexible standards.
- A solid understanding of stand dynamics is needed before training in the use of models so that users can critically judge the output they are getting.
- Organizations should be allowed to do what ever they want, as long as it is defensible. Does certification mean approval, and only approved curves and models can be used?
- I don't like the idea of "approved" models.

Tenure Reform and Additional Incentive to Involve Industry in GY Modelling

- From an industrial standpoint the biggest impediment to reaching a logically and scientifically sound conclusion is that we are "renters" of a public resource with very few formal rights. This you clearly acknowledge: implicit is the need for 1) more incentives and 2) a more democratic decision.
- I fear the lack of area based tenure and weakening of TFL tenure in BC is a root cause for lack of industrial initiatives in GY.
- Section 59 of the Forest Act which involved ACE is focussing attention on GY. This attention will get sharper as the Chief Forester actually "grows" individual polygons in spatially based timber supply models. I fear Forest Licences will not really get serious about GY until they see the benefit more clearly.

Data Collection

- Biological framework: who collects the data and what data are collected? Data are at the core of any modelling endeavour and are model independent. The new FPC can obviously make waves here: for instance a concentration of efforts in the interior and design/collection of data in "alternative" silviculture.

Forest and Landscape Level Modelling

- The report is mainly concerned with stand simulators. Forest and landscape simulators need more attention. (No mention is made of the McGregor Model Forest "Brass Ring" simulator.)

Training

- I really pushed to get a GY module into SIBC. It has proved to be very popular and badly needed. It is also delivered in Alberta where it is also popular, but linkage of stand forest level models is needed.

Exploring Licensing Issues

- Difficult – this sounds like a lot of work for lawyers.

GY MODELLING STRATEGY PRIORIZING ACTIONS PROPOSED IN THE STRATEGY SURVEY INSTRUCTIONS

Attached is a survey form designed to rank strategic areas and specific recommendations. It is being distributed to a broad cross section of BC's GY community, primarily in government and industry.

The intention is to rank the specific recommendations proposed under each strategic area. We want to know which specific recommendations you think are most important.

We have identified two key and three subordinate criteria to guide the priorization exercise. Each of the strategic areas and proposed actions in the GY modelling strategy should be ranked on a 1 to 5 scale where 1 = Very Low and 5 = Very High.

Key Criteria:

1. Importance – how important is the proposed recommendation?
2. Current level of satisfaction – what is your current level of satisfaction with respect to the issue(s) addressed by the proposed recommendation?

Subordinate Criteria:

3. Expected level of effort – how much effort will be required to implement the actions proposed under the recommendation?
4. Urgency – is the action urgently required? What level of urgency is associated with the proposed recommendation?
5. Barriers to implementation – How great are the perceived barriers which could impede implementation?

For each cell on both forms please enter either

1 = Very Low, 2 = Low, 3 = Medium, 4 = High, or 5 = Very High.

In addition, the following should be identified to provide some preliminary indications of an implementation plan:

1. **Suggested start date:** When do you think action should start to implement the proposed recommendation?
2. **Elapsed time to implement** – How much elapsed time (months) would you estimate might reasonably be required to complete the proposed recommendation?

Some individuals will feel more comfortable responding to only parts of the form. Please do not respond to any question which does not involve your personal experience.

We will rank the strategies on the basis of the information received from the survey participants. Please fax the completed forms to FORUM Consulting Group (fax: 1-250-361-9322) by **September 19 1997**.

The Ministry contact is Ralph Winter (250-387-8906). Please call Ralph or Tim Maid at this office if you require any further information.

GY Modelling Strategy

Table 1 - Developing Priorities for Strategic Areas

Enter into each cell a rank of 1 to 5

1 = Very Low, 2 = Low, 3 = Medium, 4 = High, 5 = Very High

Strategic Areas:	Importance (1 to 5)	Current Level of Satisfaction (1 to 5)	Expected Level of Effort (1 to 5)	Urgency (1 to 5)	Barriers to Implementation (1 to 5)	Possible Start Date (Year)	Possible Duration (# of months)
Organization, Administration, Liaison							
Resources							
Model Applications							
Model Inputs and Data Requirements							
Model Development, Procurement, and Operationalization							
User/Model Interface							
Training							
Extension & User Support							
Standards & Guidelines							

Key

1. **Importance** - how important is the strategic area to GY modelling strategic aims?
2. **Current level of satisfaction** - what is the current level of satisfaction with respect to the issue(s) addressed in the proposed strategic area?
3. **Expected level of effort** - how much effort will be required to implement the strategic actions proposed under each strategic area?
4. **Urgency** - are the actions proposed under the strategic area urgently required? What level of urgency is associated with the strategic area?
5. **Barriers to implementation** - How great are the barriers which could impede implementation?

GY Modelling Strategy
Table 2 - Developing Priorities for Strategic Areas

Recommendations	Importance (1 to 5)	Current Level of Satisfaction (1 to 5)	Expected Level of Effort (1 to 5)	Urgency (1 to 5)	Barriers to Implementation (1 to 5)	Possible Start Date (Year)	Possible Duration (# of months)
Organization, Administration, Liaison							
1. Formalize GY Program							
2. GY communication strategy							
3. Define role of working groups							
4. Extend planning horizon (10 - 15 years)							
5. Develop formal business plan							
Resources							
1. Secure long-term funding							
2. Promote/develop partnerships							
3. Promote coops as means to pool resources							
4. Attract required skill sets							
5. Seek out broader skill sets							
Model Applications							
1. Document required outputs for GY models							
2. Develop & implement priorization criteria							

Enter into each cell a rank of 1 to 5

1 = Very Low, 2 = Low, 3 = Medium, 4 = High, 5 = Very High

Key

1. **Importance** - how important is the strategic area to GY modelling strategic aims?
2. **Current level of satisfaction** - what is the current level of satisfaction with respect to the issue(s) addressed in the proposed strategic area?
3. **Expected level of effort** - how much effort will be required to implement the strategic actions proposed under each strategic area?
4. **Urgency** - are the actions proposed under the strategic area urgently required? What level of urgency is associated with the strategic area?
5. **Barriers to implementation** - How great are the barriers which could impede implementation?

GY Modelling Strategy
Table 2 - Developing Priorities for Strategic Areas

Recommendations	Importance (1 to 5)	Current Level of Satisfaction (1 to 5)	Expected Level of Effort (1 to 5)	Urgency (1 to 5)	Barriers to Implementation (1 to 5)	Possible Start Date (Year)	Possible Duration (# of months)
Model Inputs and Data Requirements							
1. Identify model requirements							
2. Identify "end-state" for data base							
3. Develop criteria for priorising data needs							
4. Corp. approach to data collection & storage							
Model Development, Procurement, Operationalization							
1. Formalize development/procurement process							
2. Environmental scan - for models							
3. Certification process and role of FPC							
4. Address licensing/liability issues							
5. Investment criteria							
6. Ensure FPC accounts for major models							
User/Model Interface							
1. Develop common architecture for GY models							
2. Conceptualize modelling system							
3. Simplify interface for specific models							

Enter into each cell a rank of 1 to 5

1 = Very Low, 2 = Low, 3 = Medium, 4 = High, 5 = Very High

Key

1. **Importance** - how important is the strategic area to GY modelling strategic aims?
2. **Current level of satisfaction** - what is the current level of satisfaction with respect to the issue(s) addressed in the proposed strategic area?
3. **Expected level of effort** - how much effort will be required to implement the strategic actions proposed under each strategic area?
4. **Urgency** - are the actions proposed under the strategic area urgently required? What level of urgency is associated with the strategic area?
5. **Barriers to implementation** - How great are the barriers which could impede implementation?

GY Modelling Strategy
Table 2 - Developing Priorities for Strategic Areas

Recommendations	Importance (1 to 5)	Current Level of Satisfaction (1 to 5)	Expected Level of Effort (1 to 5)	Urgency (1 to 5)	Barriers to Implementation (1 to 5)	Possible Start Date (Year)	Possible Duration (# of months)
Training							
1. Increase level of user training in the field							
2. Identify training needs							
3. Develop stand alone GY training module							
4. Reduce MOF's direct involvement in training							
5. Promote knowledge transfer							
Extension & User Support							
1. Establish user support function							
2. Keep operations informed on GY developments							
3. Investigate option of contracting out							
4. develop multi-year training & extension plan							
Standards & Guidelines							
1. Certification for GY models & yield curves							
2. Species, geographic limits, treatments, resolution							
3. Use policies							
4. Monitoring							

Enter into each cell a rank of 1 to 5

1 = Very Low, 2 = Low, 3 = Medium, 4 = High, 5 = Very High

Key

1. **Importance** - how important is the strategic area to GY modelling strategic aims?
2. **Current level of satisfaction** - what is the current level of satisfaction with respect to the issue(s) addressed in the proposed strategic area?
3. **Expected level of effort** - how much effort will be required to implement the strategic actions proposed under each strategic area?
4. **Urgency** - are the actions proposed under the strategic area urgently required? What level of urgency is associated with the strategic area?
5. **Barriers to implementation** - How great are the barriers which could impede implementation?